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INDEX TO VOLUME LXXXI

AUTHORS AND TITLES

SUBJECT MATTER

Books in Review


NATURAL HISTORY
Pigeons

NATURAL HISTORY

INCORPORATING NATURE MAGAZINE

The Journal of The American Museum of Natural History

Gardner D. Stout, President   Thomas D. Nicholson, Director

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COVER: *General Gattamelata, immortalized by Donato Donatello in 1450, gloomily scans the flocks of pigeons in Padua's Piazza del Santo.*

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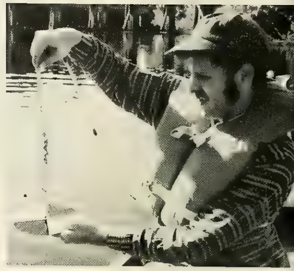
Authors

Hunting weather vanes is one of the passions **Leah Gordon** acquired with marriage. With her husband, John, an authority and dealer in Early American antiques and folk art, she has scoured the East Coast in search of the few remaining antique vanes still in use. Upon graduating from Bryn Mawr College with a B.A. in philosophy, Gordon, unable to get a journalistic position, took her first job selling shoes in California. Now a correspondent in the New York bureau of *Time* magazine, she is listed in *Foremost Women in Communications.*

J. O. Harvey worked an 86-acre farm in Bucks County, Pennsylvania, from the early days of the de-

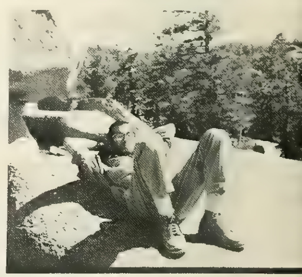
pression until very recently. The experience gave this month's "Naturalist at Large" a perspective on the environmental crisis not common in today's ecology movement. Her field experience involved hauling manure, preparing ten-acre seedbeds, and harvesting crops; her main sustenance came from growing, cutting, freezing, and eating hybrid cattle. She now lives on a farm in Glade Spring, Virginia, where she raises sheep and studies tobacco culture. Harvey holds a B.A. from the University of Pennsylvania.

When he began work on his doctoral thesis on avian reproduction biology at Rice University, **Norman Woldow** was faced with the necessity of finding a research bird that was easy to observe and that had a long breeding season. With only a small budget, it wasn't long before he settled on the pigeon. His interest in the history of the common pigeon stemmed from his observation that it moved from building to building in the manner first described by Pliny the Elder. Woldow is a senior biologist and director of field operations for the Environmental Control Services Division of Southwestern Laboratories in Houston, Texas, where he has developed a new procedure fo mapping small lakes and is devisin limnological techniques for sanitar



engineers. Part of this work entail checking water turbidity (*above*) Woldow plans to continue studying the relationship between humar population concentrations and sur vival of wildlife.

A native Californian with a Ph.D. in geophysics from Stanford University, **Russell Robinson** has had a natural laboratory in the San Andreas Fault. His investigations of the seismic phenomena associated with the periodic tremors and



quakes emanating from the fault led him to further field work in Utah and Washington. Laboratory research on the effects of high temperature and pressure in rock-fracturing mechanisms was the next step. Robinson is now safely in New Zealand, where he is trying to learn more about the possibilities of predicting earthquakes by studying

he character of foreshocks. His interest in predicting earthquakes was stimulated by the usual questions asked of him by laymen. He reports hey go something like this:

"What do you do?"
"I'm a geophysicist."
"What's that?"
"I study earthquakes."
"When's the next one?"

The lack of information and the controversy surrounding the existence of the red wolf led **Ronald M. Nowak** to conduct field investigations into the status of the animal in Louisiana and neighboring states. The work covered a period of five years, leading to his present research into the taxonomic relationships among all the living and extinct species of North American canids. A Ph.D. candidate in zoology at the University of Kansas, Nowak plans to study the past and present relationships of man and wildlife, and the ecology and conservation of endangered species.

Wearing native headgear. **Michael Jenkinson** discusses tribal life-style and shares a humorous moment with a Tarahumara youth. Jenkinson has long been fascinated with the natural history of his adopted Southwest and of northern Mexico. Born in Pontefract, England, he became a free-lance writer and poet after obtaining a B.A. in English and anthropology at the University of New Mexico. It was on one of his many trips into the barrancas country of the Sierra Madre that he first encountered, and began studying, the Tarahumara Indians.

Karl Kernberger, photographer of "The Glory of the Long-Distance Runner," accompanied Jenkinson on trips into the barrancas, and together they have collaborated on numerous articles about the region. Their book, *Wild Rivers of North America,* will be published in the spring by E. P. Dutton.

In 1968, when the first Triassic fossil vertebrate recovered in Antarctica was brought to **Edwin H. Colbert** at The American Museum, he identified it as the fragment of an amphibian jaw. This find had so many implications that an expedition to Antarctica to specifically search for fossil vertebrates was undertaken. In short order, comprehensive deposits of Triassic amphibians and reptiles were uncovered by a team led by "a very excited old man." Interpretations of this material leave little doubt that Antarctica and Africa were joined in the early Triassic. Now curator emeritus of vertebrate paleontology at The American Museum, Colbert is in busy "retirement" as curator at the Museum of Northern Arizona, where he is continuing his study of antarctic fossils.

Letters

The Use and Misuse of Technology

I take issue with the philosophy that rampant technology is raping the world and will inevitably destroy us all, and that those relatively few people gifted with the wisdom to recognize the coming catastrophe are too few and their voices lost in the roar of the crowd.

The review by Edward Abbey ("Living on the Last Whole Earth," November, 1971) says, with regard to the people who "attempt living on the earth": "It may be the only hope we have left in a world that seems headed for ecological disaster or, what may be worse, a total triumph of technology." Thus we get the picture: Victorious Technology, sword in hand, standing astride defeated man like Perseus with the head of Medusa. Presumably just offstage are the scientists, engineers, and technicians who created these machines, grinning evilly as they contemplate the thoroughness of their work.

We should take a look at those happy backward countries of limited technical development where the people "live on the earth." I am sure that these people, ridden with disease and deformed by malnutrition, die happy knowing that at least they didn't die from polluted water. Or if they did, it was cattle excrement and not some chemical plant up the river.

Abbey says that "new communes are started every week; few survive." This may be true, but is it because technology has doomed them from the start, or because the workers on these communes simply don't have the skill to perform the always difficult task of wresting a living from the earth? Or is it that they have become so acclimated to having a wide variety of foods to pick from that they have forgotten that, in the days of the earth-dwellers, people lived on simple, almost Spartan diets of almost no variety?

Technology is a necessity; it came about because man recognized his need for it. Technology is a tool; it may be seriously misused. If I design a pick to dislodge stones from the ground, sooner or later someone will use this pick to murder his wife. Am I therefore culpable? I think not.

Abbey also asks the questions: Do you *really* want to live in a Plexiglas city? And do you never want a private thought for the rest of your life? *My* answer to both of these questions is an immediate "No." But apparently the majority of the U.S. population would answer the first question "Yes." Apparently they want cities and neon lights and go-go joints and noise. And, apparently, most of them never have a thought, private or otherwise. The relative few who "swim against the tide" (and I include myself) must find a way to keep productivity high and yet not have technology destroy nature; we must master technology and put it to our own uses. How . . . I don't know. But I know that the problem won't be solved by brandishing fists at technology or retreating into the wilderness.

I think that there remains much that is good and beautiful and satisfying in the world. I don't think that insects and disease and hunger are among them, and technology is our most potent weapon against these perennial plagues of man. And though I don't want to live in a Plexiglas city, neither do I want to starve, and watch others starve, in a wilderness.

JERRY F. O'DONNELL
Del Mar College
Corpus Christi, Texas

Up the Slide, Safely

I am writing to complain about something that has often bothered me—Leslie Gourse's tale ("Up the Slide," NATURAL HISTORY MAGAZINE, November, 1971) serves as a perfect description of what I find upsetting.

It seems never to fail that those who call themselves competent in a field are often careless and negligent of novices they introduce to their pursuit. "Sly Sy," expert mountaineer, should either hike only with other experts or he should be more open with his know-how when taking along first-timers.

Two things that can be presumed to be familiar to the veteran hiker are (1) the importance of appropriate footgear (and other clothing: a fact Sy is familiar with, as evidenced by his ever-present bedroll) and (2) the necessity of recognizing and staying within the strength of the entire climbing party. The old saw about a chain being only as strong as its weakest link holds true in this case as elsewhere.

Both of these factors Sy seems to have ignored: unforgivably. The girls were "slightly cussed out" for their footwear, but this was at the base of the climb. Why not offer some information when inviting people along? As for pushing onward to the glorious summit . . . ! One would think that with all the peaks already to Sy's credit, he would not need one more 4,000-footer at the expense of others' pleasure and possible safety.

Not only does an ill-prepared and overtired party put itself in jeopardy—there are also rescuers to be considered. Mountaineering journals are full of accounts of accidents and rescues; the accounts appear in order to forewarn others. Is this why Leslie Gourse laughingly wrote "Up the Slide"? Is she warning readers about Sly Sy and his ilk, reminding readers that "you can get killed?"

Everyone needn't want to go for a second hike, but each person ought to have a reasonable and prepared first experience.

ALICE S. PERRY
Penacook, New Hampshire

Early Warning Service

Helen Hays and Robert Risebrough are doing us a great service by investigating the terns on Great Gull Island. NATURAL HISTORY MAGAZINE expands the service by bringing its readers the information. So often we hear discussions, read articles, letters-to-the-editor, etc., claiming that the loss of a few birds is not significant—man and his works are what count. The fact that events such as the deformed terns, thin-shelled hawk eggs, etc., serve as early warnings (much as the miner's long-ago use of canaries) has been lost on too many people. This important point is brought home clearly by the authors of "The Early Warning of the Terns."

DIANE T. GRAVES
Princeton, New Jersey

Vane

Detail from Botticelli's *Birth of Venus.*

f the Wind by Leah Gordon

The Greeks used them. The medieval church made them popular. But it was American pioneer craftsmen who created the finest weather vanes of all

The wind is the most ephemeral and ubiquitous of nature's forces. It cannot be bottled like rainwater, or shoveled like snow, and its moods are wild and fickle. At its best, it is a caressive, soothing zephyr; at its worst, a swath of cyclonic destruction. Man has been able to measure, predict, and harness it to propel his ships and power his windmills, but the wind remains an elusive phenomenon.

Early man was understandably puzzled and curious about the ghostly winds that surrounded him, and he grappled with them in his own primitive way. In an effort to detect the shifting winds, which he knew signaled both daily and seasonal weather changes, he observed the bend of the trees, the curling smoke above his fire, and the drift of the clouds. As with modern man, weather was an essential factor in the daily life of primitive man, and it is not surprising that the wind vane was one of the first meteorological instruments devised. With it, man could determine the wind's direction and could thus, with some degree of accuracy, forecast the weather that would follow.

Copper vane, mid-nineteenth century, New York State

Just who set up the first wind vane, and where, is lost in history. But in the first century B.C., the Greek astronomer Andronicus built a horologium, which he called "tower of the winds." The original structure, still standing on the site of the Roman agora in Athens, shows that the octagonal tower faced the eight points of the compass, with each side topped by a frieze of figures representing the winds. To give character to his tower, Andronicus crowned it with a huge bronze figure of Triton, and in the hand of this half-fish, half-man demigod of the sea, he fixed a rod. The figure turned in the wind, like a modern mobile, pointing its wand in the direction from which the wind blew. It was the first known attempt to make the wind vane something more than a practical scientific instrument, and it set the custom, which has prevailed for centuries, of decorating architecture with an esthetic object, the weather vane.

Once Andronicus pointed the way, wind vanes, or weather vanes as the more decorative forms are called, became familiar figures atop Roman villas and other pre-Christian structures. To the Greeks and Romans, the winds had divine powers and personalities. Boreas was the winged and wild demigod who embodied the north wind. Aeolus was king of the winds and kept his subjects in a cave, letting them out one by one. Mercury, Hermes, and Pan were wind deities; the vanes that signaled their passing became harbingers of fortune or adversity.

The weather vane gained further popularity under the Christians when a ninth-century Pope decreed that every church be capped by a cock, an emblem of Saint Peter and an allusion to Peter's guilt for denying Christ on the eve of the Crucifixion. Up on the steeple, the cock was combined with the simple wind vane, beckoning the faithful to prayer and the sinner to repentance. As an ecclesiastical symbol, the weathercock became an important fixture. Even the eleventh-century artist of the Bayeux tapestry honored it, depicting in one scene a medieval craftsman fastening a rooster vane on the tower of the recently built Westminster Abbey.

While Christendom embraced the cock, Viking warriors bedecked their ships with quadrant-shaped vanes akin to the bannerets and crests that grew out of medieval heraldry. Richly gilded and engraved with pagan motifs, these copper and bronze vanes are thought by some historians to have

Carefully crafted farmer at work was once a painted tin vane turning in the wind on a Pennsylvania barn roof.

denoted the owner's rank. Others believe they were just another costly, albeit brilliant, embellishment on warships dressed for battle. Unlike land vanes, these vanes did not give the wind's true direction but only indicated a combination of the vessel's and the wind's motion. It was this combination that aided Viking navigators in deducing true wind direction.

During the Middle Ages and the Renaissance, the weather vane appeared on churches, châteaus, and castle turrets, and as cities grew across Europe, on public buildings. The cock, the banner, and the simple arrow were the prevalent forms. In their rebuilding of London after the Great Fire of 1666, Sir Christopher Wren and his architects made extensive use of the heraldic style vane as an architectural ornament.

Later, after the French Revolution, the weather vane became widespread throughout Europe, appearing not only on governmental and ecclesiastical structures but on the homes and shops of the common man as well. Also, by this time the cock lost much of his religious significance and became a mixed secular symbol. As the crowing chanticleer, he represented France. As the strutting barnyard rooster, he stood, like the wind he answered to, for fickleness, energy, and variability—a tiny-brained bird whose broad tail could catch even the gentlest breeze. And with its jaunty profile outlined against the sky, the

The quality of some European weather vanes is seen in this beaten-copper replica of Columbus's *Santa Maria*. Damaged in World War II and restored in 1950, it now sails in the breezes atop the William Waldorf Astor house in London.

Cocks and horses were favorite themes on early American vanes. The high degree of workmanship that went into their production has made them prized collectors' items.

bird was indeed an impressive sight.

Not until it crossed the Atlantic Ocean in the eighteenth century did the weather vane reach full bloom. This flowering was due to a number of factors. Because weather forecasting was vital to the colonists' rural and seafaring life, vanes came to play an important role. The weather vane also became a symbol of the newfound social and political equality, since any man could now raise a fancy metal banner as a kind of phony coat-of-arms over his home or barn. And most important, America attracted a class of consummate craftsmen in whose hands the weather vane was elevated to sculpture, and its maker, to artist. For these reasons, the weather vane flourished in America, reaching an artistic level that moved Picasso to remark, after seeing a rooster vane in an exhibition of American folk art in Paris, "Cocks have always been seen, but never as well as in the American weather vanes."

Shortly after the colonists erected their first major buildings, weather vanes appeared. At first they were European imports or direct copies, but Americans were soon producing their own with the vigor, directness, and ingenuity that typified all American craft. In fact, some of the most impressive and significant American weather vanes were fashioned during the eighteenth century. Among them was Paul Revere's wooden codfish studded with large copper-head nails, which stood on the roof of his coppersmith shop at Canton, Massachusetts. Another was the four-foot-high sheet iron rooster that revolved atop a church in Saddle River, New Jersey.

Perhaps the most famous American vane is the copper grasshopper with a green glass eye and antennae pointing into the wind that since 1742 has turned atop Faneuil Hall

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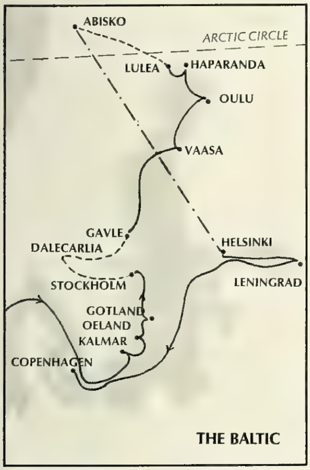

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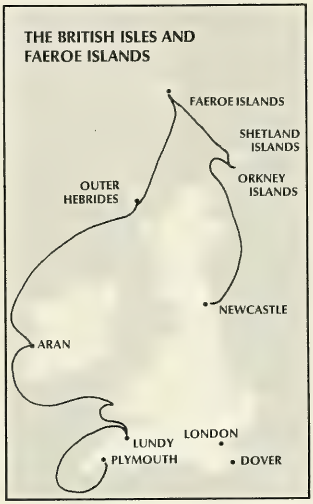

You will see Lundy Island and sail up the Severn to visit the Wildfowl Trust sanctuary at Slimbridge.

Gowan Peninsula and the Pembrokeshire islands are stops before proceeding to Bull Rock, Little Skellig and the three Aran islands in Ireland. In the Scottish Hebrides we enjoy North Rona and Sula Sgeir; and you will never forget the island of Hirta in the St. Kilda group. Mykinesholm and Torshavn are included in the Faeroes; and in the Shetlands we land at Unst, Muckle Flugga and Lerwick. Close to the Orkneys is fascinating Fair Isle. On the Isle of May we visit the first Scottish bird observatory, going back to the twelfth century. The gannets at Bass Rock are fantastic; and at Farne Islands, back in England, we land at a bird reserve established in 686 A.D. by St. Cuthbert.

Enough of name dropping—but few have ever seen the British Isles this way.

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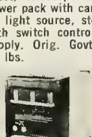


in Boston. The work of Shem Drowne, America's first professional weather vane maker, the Faneuil Hall grasshopper was for years the standard test for derelict American seamen abroad seeking a handout or free passage home from American consuls. Simply identifying the grasshopper as the vane on Faneuil Hall was adequate proof of citizenship. Drowne might have chosen this lowly, ceaselessly chirping insect for his most memorable work because it symbolized agriculture or, more likely, because the grasshopper was the heraldic crest of Sir Thomas Gresham, founder of London's Royal Exchange, the building after which the Boston merchant's market was modeled.

Shortly after the Revolution, local tin and copper smiths were devising weather vanes whose shapes and patterns went far beyond the imagination of anything their European counterparts had so far produced. Unburdened by European tradition, the nineteenth-century craftsman, as well as his customer, let whim, humor, and superstition dictate design.

Animals and fowl of every description—horses, dogs, cows, rams, peacocks, pheasants, stags, and, of course, the perennial rooster—soon appeared over farmers' barns in New York, New Jersey, Pennsylvania, and New England. Subjects were often related to the immediate environment and locale. Along the seafaring eastern coast, whales, codfish, mackerel, swordfish, dolphins, mermaids, and square-rigger ships were popular. In the South, where ties with English tradition ran deep, banners and standards, harkening to heraldry, were preferred. One exception was George Washington who, upon his return from the war in 1783, ordered a dove for the cupola on Mount Vernon.

As a new nation, patriotic fervor was boundless, reflecting itself even in the weather vane. The new national symbol, the eagle, appeared on countless courthouses and town halls, along with Columbia, the Goddess of Liberty, and the snake ("Don't tread on me"). Even George Washington on horseback

Indians were a popular motif on many early Pennsylvania weather vanes.

became a suitable theme. The variety of subjects was legion and sometimes extreme, such as the witch on a broomstick that was discovered a few years ago in Salem, Massachusetts, or the wall-eyed pike that was taken down from an old inn on pike-filled Lake Cossayuna, north of Albany, New York.

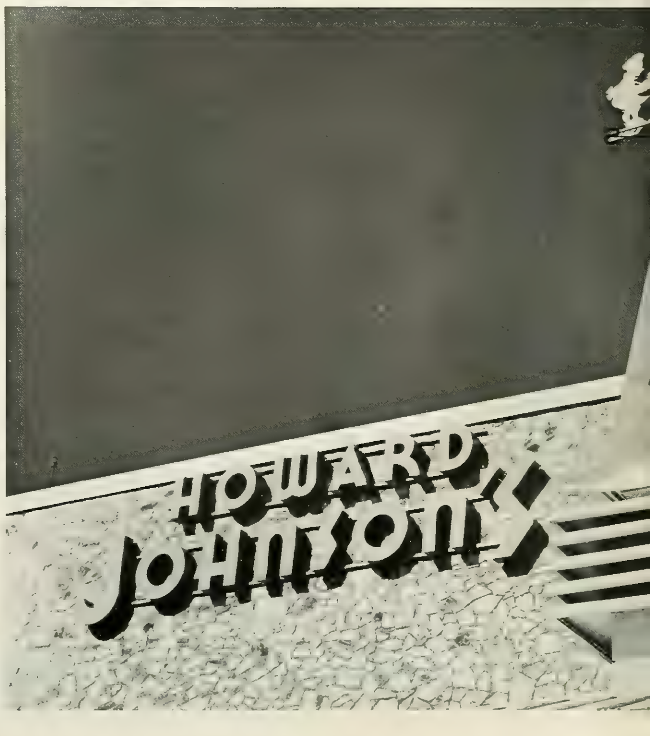
But it was the horse, the animal so intimately involved with the growth of the nation, that became the most popular theme. The symbol of work, transportation, sport, and recreation, the horse was fashioned in every conceivable way by nineteenth-century weather vane makers: running, jumping, plowing, trotting, carrying Indians and jockeys on its back, and pulling sulkies at its tail. The horse, exemplifying strength, grace, freedom, and motion in its shape, no matter what its stance, became sculpture in the sky.

American churches also embodied an independent spirit, breaking away from the traditional European weathercock. Although many a rooster continued to point the way of the spirit, it was joined by an elaborately cutout arrow, a lyre, fish (a metaphor for Christ), and the angel Gabriel. Gabriel was a particular favorite during the great religious revival of the mid-nineteenth century when, it was predicted, the millennium would be heralded by the trumpet-tooting flying angel.

In the inland areas of Pennsylvania and New York, the Indian was a frequent, albeit curious, subject since his relations with the white man were, at best, ambivalent. Nevertheless, he was a favorite form, possibly because he was a friend of the colonists during their earliest trials. Or, as folk art historian Jean Lipman suggests, "The Indian vane may have been a practical means of keeping marauding Indians away by indicating amity between the white man and the Indian."

Among the numerous Indian vanes that have been found, none reaches the style and power of Chief Tammany, now in the collection of

Today's highway culture is typified by this roadside vane.



the Museum of American Folk Art in New York. Made in about 1840, this nine-foot, gilt copper figure holds a bow in one hand, an arrow in the other. The figure is elaborately detailed with clothes, feathers, hair texture, and fingers. For many years Chief Tammany stood atop the political clubhouse in East Branch, New York, at the western edge of the Catskill Mountains. The owner of the ramshackle building was well aware of his prize and refused all offers. Finally, a few years ago he drove a bargain with a nearby antique dealer: buy the building and you buy the vane. The dealer did.

By the mid-nineteenth century, the industrial revolution had taken firm hold in the United States and the weather vane, like so many other objects, fell to commercial, large-scale production. No longer the work of free-wheeling artisans, vanes were now made in factories, although still by hand. The commercially made vanes became more realistic and formal, with pedestrian designs replacing the more in-

Continued on page 78

A Letter from a Farmer

"I surely do wish that some of this sudden affection and solicitude for the environment would engender respect for the land that is used to support us all"

by J. O. Harvey

I have been pondering NATURAL HISTORY MAGAZINE's ecology questionnaire (June-July, 1970), and the responses to it, for more than a year. I did not answer the questionnaire because my "personal experiences and opinions" could not be amputated to fit.

I happen to be one of the anonymous two million who put food on your tables. Industry cannot feed you, but we can feed you because we know that you cannot eat money. I learned this important fact back in the depression of the 1930s. That I am still an active farmer proves that I have taken care of my environment, as a farmer must if he is not to go broke.

For most of my sixty-five years I lived and learned and made a living on a small farm in Bucks County, Pennsylvania. I doubt if many NATURAL HISTORY subscribers have known one locality so intimately, so long. For me, ecology and pollution were not born yesterday.

When my father bought the place back in 1905 there was a well in the corner of the barnyard for watering the livestock. When our pet pig fell into it, father set about sealing the well with concrete, and our occasional hired man complained because the well had the best drinking water on the farm. Both pig and hired man survived—the latter to the age of ninety.

A pet pig, in fact, all farm animals, invariably give us humans some rough emotional moments. No scientist studying rats in a cage or lions in a park has any conception of the personalities animals display when we work with them all day and every day. Most of us hunt rabbit, deer, and game birds for food. Some few may enjoy the sport, but if you want to see a farmer turn green, just ask him if he has ever mowed the legs off a baby rabbit and had to kill the thing with his bare hands.

We dispose of our domesticated animals when it is a question of survival—them or us. At such times, I remind myself that I am only shortening an already brief life-span. We suffer, too, when our useful farm dog dies in our arms, or the horse that has carried us proudly for twenty years tries to cut a caper to prove he is still a horse, although he is swaybacked and nearly blind.

A suburbanite or city resident can have convictions about the rights and privileges of animals. I do not have convictions; I only have experiences.

Speaking from experience, rather than conviction, I *know* I am not, to quote the questionnaire, "responsible for our present state of pollution," and I have no hope that our environmental problems will be solved by government authorities, industrial corporations, revivalists, beatniks, bureaucrats, technocrats, or politicians, none of whom really gives a good goddamn about anything beyond immediate profits, self-preservation, or private peace of mind.

The farmer is different; he is on the ground. He knows what pollutes his land and he copes with it, or he cashes in his chips and relocates to a state more hospitable to agriculture, as I did when I moved to Virginia. When I left it, the Bucks County farm represented 90 percent of my lived life. I was there, watching my country being fragmented and despoiled. The deterioration of the environment was specific and factual.

Erosion besets the farmer before it attacks his farm. The best farmer in the world will still get only a slight margin of profit beyond his cost of production for milk, eggs, broilers, and beef; although for beef, local freeze plants are slowly undermining packer prices.

Also, the best farmer in the world will not be able to improve his land, repair his buildings, hire labor, or buy a $3,000 potato picker if Campbell's Soup Company pays him $38 a ton for tomatoes that cost $23 a ton to grow, on land that is highly taxed. For the first thirty years of this century the cheapest way to acquire a Bucks County farm was to invest in a farm mortgage.

So the land deteriorates. Tilled land is left without cover crops, creek banks cave in, and productive land grows up in swamp elm and cedar trees. In 1931, when I went back to growing three meals a day, I found the neighboring farms were mostly occupied by grandma and grandpa, with a horse—or model-T Ford—a couple of cows, a few chickens, and an employed but absent daughter who sent home money for taxes and interest on the mortgage. Our farm was unmortgaged, but I had to pull trees out of every acre before I could plow. By 1939 we still had so many six-inch dogwoods and red maples decorating our pastures that we sold $300 worth to a gentleman who dug them for replanting on New York's World of Tomorrow fairground. That year we paid our own taxes.

When the Agricultural Conservation and Stabilization Administration went into action, it paid 40 percent of the cost of rebuilding fertility with nonnitrogenous fertilizer and of stabilizing the soil through forestry practices, ponds, diversion ditches, and improved ground cover. My neighbors and I all needed these items, but none of us had the required 60 percent cash. I worked at a nearby inn to earn my first tractor, purchased from a junkyard for $35, delivered.

Impoverishment set the stage for pollution. Our Pennsylvania farm has close to half a mile of frontage on what is now a state highway. The original dirt road was perhaps 20 feet wide, and where it climbed our steep hill, hillocks every 60 feet drained the floodwater into the adjoining fields, but in moderate installments. Rebuilt to state specifications, the right-of-way was widened to 40 feet, the roadbed raised and paved, and now the whole hill drains its floodwater into our pasture, where it has produced a bottomless swamp. My father complained and was paid $16 damages. In 1942, after the grass had been frosted, a horse I was boarding got into that swamp and died.

At the north end of our road frontage, there is a very old handdug well. It is 300 feet from the house and about 10 feet higher, being uphill. A lead pipe leads from the well to our cellar. In times of electrical failure we could use this well for the barn and downstairs bathroom. When hurricane Hazel went through, every other barn was without water for three days. Naturally we value this old well, but every few years the state highway engineer moves his roadbed farther from the solid old forest on the other side of the road, and digs ten feet more out of my road bank.

In 1967 the bulldozer laid bare the actual dry stone retaining wall, which lines the old well. Six months later, a horrible accident at the top of the hill scattered brains and blood all over the highway, and enough drained into our well to set up a pseudomonas infection that af-

fected our cattle with disastrous diarrhea and presented us with a sizable veterinary bill.

I had already been writing regularly, but fruitlessly, to the local state highway maintenance man and to the district state engineer, asking for a protective wall around the well and for the gutter to be paved for some thirty feet to prevent seepage into the well. I wanted to get this work done before winter because the chemical used to melt snow was plainly killing our roadside shrubs and probably would not do our animals any good.

My letters accomplished nothing, but it finally occurred to me that I was writing to hired technicians and not to elected officials vulnerable to public dissatisfaction. So I wrote one more careful letter to the district engineer and sent a carbon copy to the governor. Five days later the district engineer appeared in person; the following week the well was waterproofed.

I do not have environmental convictions, but I do have a suspicion that laws to protect the environment should be aimed, not at the private citizen, but at the government's myopic hired hands who build roads and dams and parks and sewage lagoons as if the country were good for nothing else. And in a very few years, the hired hands may be right. Already so much of eastern Pennsylvania is macadamized that the seasonal rains overflow the highway gutters, cut gullies to the nearest creek, and are gone forever. The land is so thirsty that two weeks without a shower will stunt the corn, and market gardeners must irrigate their land if they hope to survive.

You can believe me, a highway engineer's vital concern is to comply with state or federal specifications so the road will be eligible for state or federal funding. The bigger the road—or pond—the larger the subsidy.

For years the Pennsylvania Department of Forests and Waters has been working on "Project '70," created to keep the state green with federal grants for parks and ponds. In Bucks County a local educator suddenly became a dedicated conservationist and sold the county commissioners the idea of establishing a water resources authority, of which he is now director. This

authority is in the process of building four dams.

The "flood-control dam" to occupy 31 acres of my farm floated me right off the property. The debris and pollution restrictions on my remaining 50-some acres made general farming impossible. I was delighted to be liberated, however, as I had somehow formed the conviction that the county had been taken over by megalomaniacs. To draw $3 million from federal funds, the new high school had to cost $8 million and have a swimming pool, stadium, and science and biology laboratories. The "cross county" projected highway, 30 miles long, had to be a limited access, double-barreled affair, with maybe a 500-foot average right-of-way.

The only place for a truly grandiose flood-control dam was on my section of the unfortunate creek, where the ground rises steeply—50 feet in maybe 200 yards. My neighbor across the creek has a corresponding hill standing back from the creek and separated from it by about a hundred yards of lush green pasture. The earth dam is to be 43 feet high and there is not enough clay in the vicinity to bridge between the hills. The whole creek is approximately five miles long but there are no proper hills beyond my property, so the dam has to be within the first mile of the inoffensive streamlet that I was able to cross dry-shod when I was five years old.

Furthermore, four-fifths of the watershed, and all the storm drains from a couple of square miles of Newtown and vicinity, are downstream from the flood-control dam. As a consequence, the 10-acre, permanent pond will mostly depend on the spring freshets for a supply of water and, I might add, mud.

Far from improving the environment, on my neighbor's side of the creek this installation will drown 30 acres of ancient sod too valuable as pasture to have ever been plowed. On my wooded hill, clean young tulip poplars just coming into money at an average diameter of fifteen inches, will probably be ground into matchwood and burned. And then my denuded hill will scour into raw clay as the pond level fluctuates because of the erratic water supply from an insufficient watershed. I have known this creek all my life and I am sure there will be no sufficient, continuous overflow to clear the pond of algae and mosquitoes in summer.

I am a farmer; I do not need much land to make a living, but I do need reasonable neighbors. And you, conservationists, with your convictions and your dedicated intentions to save the environment, must watch your step or be led down the garden path to outsized projects that do not even fit the environment, let alone improve it. I surely do wish that some of this sudden affection and solicitude for the environment would engender respect for the land that is used to support us all.

Unless you can live on wild nuts and berries, the natural environment cannot support you. Only farmland, properly used and maintained, can support your life—and mine. ■

Pigeon and Man: A Spotty Old Friendship

This persistent bird, whether we worship or curse it, follows human civilization toward its uncertain destiny

by Norman Woldow

In a world increasingly dominated by megalopolises, superhighways, intensive agriculture, and other works of man, only a handful of animals can thrive. The common, or domestic, pigeon (*Columba livia*) is a member of this uncommon group.

Before civilization, this pigeon was rare and specialized. Then man became its inadvertent companion and benefactor. Now, when most bird populations are declining because of man's reduction of their habitat, the common pigeon is about to expand further in both numbers and range.

Although their numbers are decreasing, a substantial wild population of the common pigeon still remains, confined largely to remote coastal mountain ranges in northern Europe and the Balkans. The pigeon has also declined as a domesticated animal, owing to its unsuitability for modern automated animal husbandry. In most places, domesticated varieties are kept only for sport, ornamentation, and local poultry use.

Only the feral population of the common pigeon continues to exist in vast and increasing numbers, despite man's efforts to reduce its population. These pigeons, while independent of human control, inhabit the immediate human community. Ornithologists have called them feral, indicating that the pigeons found in cities and countryside are escapees from domestic flocks. But early historic sources disprove this view, showing instead that man and pigeon came together as natural companions long ago.

The natural histories of pigeons and men have been intertwined since the Neolithic period in human history, when man progressed from hunting and pastoral civilizations to agriculturally based, settled communities. At this early point in history, a series of unique habitat overlaps brought man and pigeon together. For millennia, pigeons have been a source of artistic and literary inspiration for man, but their swarming flocks have plagued him as well. Today they are damaging outdoor art and architecture in cities throughout the world.

In Venice, perhaps the world's urban complex closest to collapse,

A British sailor, pleased by his most recent conquests, feeds the pigeons in London's Trafalgar Square. A flock descends, next page, to a feeding area near Central Park in New York City.


PEMBROKE

pigeons are a major source of damage to sculptures and monuments. In conjunction with air pollution from industrial installations, pigeon dung in vast quantities is corroding the stone of which the city is built. Over the years, many of the city's art treasures have eroded beyond recognition. In a way, the pigeon has become so enmeshed with civilization that it mirrors man's own duplicity of creative and destructive force.

Because of its closeness to our daily life and its availability for scientific study, the pigeon is better known anatomically and physiologically than any other bird. Its social behavior is also well known from observations in laboratories and the field. Its homing ability, unique among domestic animals, has been well studied if not all that well understood.

The relationship between man and pigeon started toward the end of the last Ice Age, when the bird's distribution was restricted to a relatively narrow band of moderate climate in the Northern Hemisphere. The pigeon is far more selective and specialized in its habitat requirements than man. It requires steep, sheltered cliffs and inaccessible ledges on which to roost and breed, yet, at the same time, there must be extensive vegetation and water nearby. One such early habitat was in the hill country of present-day Iraq and Iran in the Near East. Although man and nature have changed the ecology of the region, there are still large numbers of pigeons there. In fact, some of the remaining, representative colonies of wild pigeons live in this region and in the Balkans, to the northwest.

The Near East was also a major center for man's shift from a hunting and herding civilization to agriculture. In this revolution, man began to cultivate a number of grain plants, which still provide us with the bulk of our staple food and sustain our ability to live in settled communities. With man and pigeon together in place and time, the stage was set for a merging of habitats. For as man settled, farmed, and built houses, he changed the face of the land, making a new world not only for himself but for pigeons as well.

Agriculture began on gentle slopes, where soil and drainage were right for the various cereal grasses. These regions were fine potential feeding grounds for pigeons, but they did not necessarily provide the crucial nesting sites and roosts. Neolithic settlements close to cliff roosts were probably already feeding grounds, but others were too far away from high cliffs.

From my studies of the modern pigeon, I know that safe shelter is the primary limitation on the bird's distribution and individual survival. Our ancestors' efforts to provide themselves with permanent shelter proved attractive to their pigeon neighbors, and the birds moved into this emerging habitat, perhaps as it was being built. The houses and villages of the Neolithic farmers were architecturally simple, but they admirably provided the basic features of shelter and comfort for the pigeon—it was as if new cliffs had sprouted for pigeons just where food and water were most available.

Excavations of several protohistoric civilizations have revealed that man and pigeon cohabited these early settlements. Not only was the pigeon prominent, it was also regarded as a sacred animal associated with Ishtar, one of the most important goddesses of the period. Ishtar was long worshiped as a fertility symbol for both crops and man. The pigeon's habits and behavior fit in nicely with a fertility religion. Pigeons are conspicuous in their mating, have a long and productive breeding season, and their squabs grow rapidly. Indeed, they are outright models of fertility.

Another important factor that placed pigeons in the religious scene was their great attraction to temples—not as temples, of course, but as the largest, best, and safest structures that man built. A house or barn might be small, but the temple would often be a splendid building. Even today, in many small villages of the world the temple may be the only building large enough to provide adequate shelter for nesting a large flock.

In time, the small villages of the Near East bloomed into the great Mesopotamian civilizations, moving down from the hills into the fertile lowlands adjacent to the Tigris and Euphrates rivers. These civilizations were urban, agriculturally based, and architecturally advanced. Where none had previously existed,

A pigeon, an agricultural pest at the time, stands among the birds pondering the words of Saint Francis, painted about 1452 by Benozzo Gozzoli.

A pigeon, above, flies from its roost on a Detroit church. On a ledge between a pillar and an air conditioner, a pigeon built this nest outside the offices of *Natural History Magazine* in New York City.

they used brick to raise, from the pigeons' viewpoint, high cliffs on plains. The implications for the future pigeon populations of the world were clear. Much of the world was soon to approach an ideal, a golden pigeon age, where on every continent man would construct huge complexes of cliffs and ledges on which pigeons might nest.

It is almost certain that the Mesopotamians did not have the pigeon under direct domestication, yet the bird was present in large numbers and held an important place in their art and religion.

Agricultural-based civilization, diffusing from Mesopotamia and probably from several other centers, revolutionized the world. Within a few hundred years, agriculture had reached the Middle East, India, and Egypt, and was working its way into eastern Europe. Cereal grain, mainly wheat and barley, spread like cultural wildfire. Communication between regions was active in this early period of civilization, approximately 5,500 years ago. Considerable trade took place in all crafts, particularly of metal objects, while between the more remote parts of the ancient world, sheep and goats were exchanged.

While domestic plants and animals spread rapidly throughout the ancient world, independent pigeon

populations, working on their own, diffused only slowly from the Near East. In Old and Middle Kingdom Egypt, only ringed and turtle doves appear in wall paintings, and these are clearly wild, along with many other wild animals and birds. Because the nearby marshes of the Nile provided an ample supply of desirable waterfowl, the first fully domestic birds in Egypt were the graylag goose and the mallard. In India, to the east, the Aryans were busy depicting and recording the husbandry of their domestic bird, the chicken. Upon domestication, the goose, the duck, and the chicken were widely traded and reached worldwide distribution long before the partly domestic pigeon appeared outside its ancestral homeland.

It is hard to say exactly when domestication of the pigeon took place. By Biblical times, the bird appears to have been domesticated, although the evidence for this is not conclusive. The bird seems to have been significant in early Judaic observance, probably because of the close ties between Judaism and the Mesopotamian civilizations.

By the fifth century B.C., the Greeks began to show domesticated pigeons on their statues and vase drawings. A large number of renderings show people holding pigeons that are clearly not resisting. In many, the birds are billing, or kissing, the person and in one, a little boy is letting his bird fly, as is done with sporting breeds of pigeons such as homers or tumblers. A number of the statues show children with pigeons, suggesting the bird's role as a pet. Domestication is confirmed by Pliny the Elder's descriptions of several distinct breeds, the life of the still plentiful wild pigeon, and pigeon culture.

More important than the exact time of domestication is the unique form that pigeon husbandry took. For most animals domestication eventually meant that man confined, provided for, and regulated their lives. Man often brought the animal food and water, for instance. For the pigeon, man's commitment was much less. According to Pliny the Elder, the Romans followed this practice: On the roof of a building they constructed a tower in which

nests could be built. At intervals, they would enter the tower and collect some squabs. All the other burdens of animal husbandry were ignored. The pigeons foraged for themselves and were free to come and go as they pleased.

In this form of domestication, the distinction between a domestic population and a free-living one is very loose. Despite the pigeon's tendency to remain attached to its nest site, considerable interbreeding and movement takes place between the nesting sites. As Pliny puts it, "They will be seen to conspire among themselves, offering bribes and corruptions to induce them to desert their own buildings and join their colonies."

This form of pigeon husbandry, which is called dovecote culture, does not create rigid partitions between populations of domestic, feral, and wild pigeons. The long survival of this system of culture has allowed continuous genetic interchange between populations of pigeons. In America and Europe dovecote culture lasted until the latter part of the nineteenth century. In many parts of the world it still exists. Moreover, in even the most industrialized cultures, some breeds of domestic pigeons, such as homers, are still allowed to fly free.

In the Middle Ages the dovecote system of pigeon husbandry became a bizarre form of taxation, allowing the nobility to exact an additional measure of wealth from the peasants. Although the lord of the manor was the only person allowed to own a dovecote, the pigeons foraged on all the land, including that of the peasants. Since the lord took a fixed rent in produce from the peasants, rather than a percentage of the harvest, he had little reason to limit his flock, which might number in the thousands of birds. In many manors, the pigeon was the primary form of domestic poultry, as was the case in Lord Barcklay's manor in the year 1326. In that year the good lord's household consumed 1,008 squabs, 91 capons, 192 hens, 388 chickens, 288 ducks, 194 pigs, plus wild game. While the other poultry was a regulated portion of the manor's produce, with some remaining for the peasants, the squabs were a clear surcharge added to the peasants' other burdens. Not surprisingly, in many of their prayers the peasants sought deliverance from the lord's dovecote.

The system of open dovecote was so close to a natural habitat that pigeons survived the depopulation of the countryside during the period of enclosure and the rise of industrialization at the opening of the modern era in Europe. Abandoned, the pigeons in dovecotes survived as nuisance populations, gathering food from the countryside, including the remaining farms. At this time the pigeon was the most serious avian pest and in some places rivaled rats in crop damage.

Pigeons were able to revert from domestic to feral conditions with little difficulty, and remained an uncontrolled rural pest until the introduction of sporting shotguns in the early 1800s. Throughout this period there were people who bucked public opinion and kept pigeons, always utilizing the dovecote system for the bulk of their birds, although they increasingly used total confinement. The predation of hunters probably spurred the rise of aviculture for pigeons. As late as the 1840s the open dovecote was still the rule in England, while on the Continent open dovecotes were seen until the First World War.

As human trade spread the goose, duck, and chicken during the early years of civilization, so exploration and colonization spread the pigeon during the Renaissance. Colonies of Portugal, Spain, France, England, and the Netherlands spread the dovecote with its semidomestic, semiferal pigeons all over the world.

Today the common pigeon is one of the most widely distributed birds. In some cities of the world it is the most abundant bird in absolute numbers, although it usually has smaller numerical strength than the house sparrow and starling. Modern cities provide abundant food for pigeons, as well as an ever expanding architectural superstructure, which enables the birds to roost at greater heights, farther from disruption. The dense construction of skyscrapers in downtown areas provides abundant shelter.

Massed skyscrapers are also effective windscreens. A vivid example of this windscreening effect can be seen on the Loop in Chicago, where the winter wind is predominantly from the northwest, off Lake Michigan. There are few pigeon roosts facing the lake on Michigan Avenue, and none on the cross streets, through which the wind blows. Behind Michigan Avenue, however, there are multitudes of roosts sheltered in the streets running parallel to the lake.

Another modern architectural innovation that has proved highly advantageous to the birds is the air shaft. This well-protected space is completely surrounded by walls and has the usual windowsills. In some of the older air shafts of Houston, pigeon dung is almost two feet deep, indicating occupation for long periods.

In the last ten years, the United States has built major segments of an extensive interstate highway system. This network of limited access highways has many overpasses, loops, and other elevated structures that present another vast habitat for exploitation by pigeons. Overpasses, entry ramps, turnarounds, and bridges are constructed largely of steel and steel-reinforced concrete, with the post and lintel and the I beam as prominent architectural features. All these constructions are roofed over by the road surface, providing protection even from rain. Optimum shelter is provided when the road runs parallel to the prevailing wind, while on roads perpendicular to the wind, pigeons can find protection only in the centers

A seagull, one of the pigeon's competitors, waits for a chance to grab some of the food being handed out in a London square.

of the road, up under the I beams.

The interstate system extends a large quantity of nest and roosting habitat into the countryside, where such habitat has been scarce in the past. Based on its past performance, the pigeon will follow this habitat extension to its saturation.

Interstate 10, for example, extends from Houston in two directions. Several small agricultural communities west of the city have few large buildings, yet they have thriving flocks of pigeons, which live under I-10. Other little towns north and south of I-10 have hardly any pigeons, usually flocks of three to five birds occupying small niches.

The road was built about fifteen years ago and now pigeon flocks can be seen as far as sixty miles from Houston. The economic impact of this expansion is unclear. Competition from pigeons in the countryside may diminish feeding habitat for such native species as doves and for other herbivores as well. Pigeons may also pose a significant threat as agricultural pests. A closely related species, the wood pigeon (*Columba palumbus*) is a serious pest inflicting damage to crops in its native Europe. Alternatively, rural pigeons could be worked into a program of game harvesting as sport, perhaps in off-season hunting.

We have come a long way since the Neolithic period, and a few commensal companions, including the pigeon, have come with us. It seems certain that these few species will accompany us toward whatever our future fate may be. It also seems strangely significant that we consider all of them pests.

Despite the damage pigeons do to buildings and sculpture, public guards feed the birds in Piazza San Marco, Venice. The ornate architecture provides many nooks for nesting.

The Rumbles on Seismos

As this mythical land slowly tears itself in two, the tiny bumps and jerks that precede major tremors hold hints of quakes to come

by Russell Robinson

In the mythical nation of Seismos, the notorious Mad Dog Fault slices through 500 miles of terrain before passing out to sea at each end. During the past 200 years or so, several large earthquakes have occurred along this fault, and numerous smaller tremors have been recorded. Moreover, detailed surveys of the fault zone have shown that the lands on both sides are slowly "creeping" past one another horizontally, the landscape on the western side moving northward a few inches a year; the eastern side, southward.

Despite this clear indication of landscape instability and severe damage in the past from large earthquakes, the people of Seismos have built large cities near, and even across, the Mad Dog Fault, and some buildings that are slowly being torn in two by the fault creep have become great tourist attractions.

As far as the geophysicists of Seismos can tell, the fault extends vertically downward about six or seven miles into the earth's brittle crust. The rocks underlying the western side of Seismos appear to be more or less rigidly attached to the crustal rocks beneath the bordering ocean to the west, while those beneath the eastern side are connected to continental rocks extending far to the east. Both of these huge crustal "plates" are fairly rigid in themselves, but tend to slide atop a zone of soft, perhaps partially molten rock beneath. The scientists do not clearly understand the enormous forces that, for the past few million years, have caused these two plates to creep past each other along their boundary (the Mad Dog Fault). Presumably, they are the result of the large-scale, but very slow, movement of rocks deep in the earth's interior. The combination of intense heat and pressure allows rock to "flow" like a viscous plastic, although the average citizen of Seismos might not think so if he has only observed rocks at the surface. The scientists of Seismos say the bulk of these continent-sized plates continue to slide past each other even when their edges are slowed or stopped by the friction along their boundary. When this happens, the inexorable force of the moving plates pulls the rocks near the Mad Dog Fault farther and farther out of shape. Finally the strain is too much; the rocks snap and spring back to their original shape. This sudden release sets up sharp vibrations in the earth—an earthquake.

In the hope of being able to predict when an earthquake will occur, the seismologists have set up an elaborate array of seismographs to record all tremors along the Mad Dog Fault. Most of these are so small that they are not felt by the busy citizens of Seismos. Although the data they have gathered have greatly increased their knowledge of the fault, the seismologists find

About 35 miles southwest of Bakersfield, California, the scar of the very real San Andreas Fault here crosses the Carrizo Plain.

that they are able to make only broad statistical predictions, such as: "Sometime in the next 50 years a severe earthquake will occur somewhere in Seismos." They do say, however, that great earthquakes appear to be inevitable.

It has been many years since an earthquake large enough to do any damage has occurred along the central section of the Mad Dog Fault, and only a slight amount of creep has been observed across the narrow fault zone. Broad-scale surveys, however, seem to indicate that far from the fault displacements continue to occur on either side. For geologic reasons the fault in this area bends slightly, and the rocks nearest the fault cannot slide easily past each other as they do farther north and south. As strains in the rocks near the fault build up almost to the breaking point, here and there small microseisms (very small earthquakes) occur, the overburdened rock undergoing slight readjustment under the tremendous load. These events have been duly recorded by the scientists' surface instruments but there is no noticeable pattern in their occurrence and life in Siesmos goes on as usual.

Scientists observing the creep behavior of the fault somewhat to the south do note a strange fact, however. Creep in that region occurs, not at a steady rate, but in jumps, or "creep events." Moreover, there is some evidence that these events may propagate northward along the fault at a slow rate. Even stranger still, sensitive magnetometers near the fault reveal minute but distinctive changes in the earth's magnetic field somewhat before a creep

These homes in Daly City, California, sit atop the spot where the San Andreas Fault emerges from the land to plunge into the sea.

The foundation of a winery building in Hollister, California, located directly on the fault, has been cracked by periodic tremors.

event is observed, and the scientists feel that they may be able to predict when a creep event will occur although they do not know exactly why this should be.

But this interesting observation about creep events is unimpressive to a farmer living near the site of an impending earthquake. Unaware that a creep event is moving northward and impinging on the locked section of the fault beneath his land, he does, however, notice strange behavior in the water level in his wells and in the flow of a small creek. At the same time an observant boater in a nearby reservoir notices odd changes in the water level there, as though the lake is tilting slightly toward the north.

It is at this moment that the increased stresses due to the approaching creep event—combined with those due to the tidal forces of the sun and moon and the changing atmospheric pressure—increase the strain in the overloaded rock to a critical level. The mile-deep stone, already weakened by a previous series of microseisms, is weakened

An unfinished overpass collapsed onto this highway in the San Fernando Valley when an earthquake hit Los Angeles last February.

still more by increased water pressure in the pore spaces, and the strains, relentlessly building up, become great enough to cause a small rupture in the rock. This crack propagates outward at great speed (nearly two miles per second) because its mere presence tends to further intensify the existing stresses at its edges; thus, the earthquake begins.

As the rupture propagates up and along the fault, the bordering rocks spring back to relieve the strains in them. At the surface, about 15 feet of lateral displacement occurs, which gradually tapers off to zero at a distance of 25 miles either way along the fault, as the strain energy stored in the rock becomes insufficient to extend the crack farther. Some of the waves generated in the rocks near the rupture travel at great speed through the body of the earth to distant seismograph stations. Other, bigger waves travel along the surface and, with the permanent surface displacement itself, cause severe damage in Seismos City, ten miles to the north of the initial break.

Swarms of seismologists flock to the area of the earthquake and set up elaborate networks of instruments that, over a period of several months, record a series of aftershocks (smaller tremors occurring later in time but physically near the main shock). The magnitude of the earthquake is estimated to be 8.2 on the Richter scale, a great earthquake indeed. Seismos City is declared a disaster area and everyone wonders why he didn't have earthquake insurance.

Long before this earthquake occurred, geophysicists had been monitoring all the physical effects they could, in the hope that after an earthquake, they could identify any phenomena that had foreshadowed the event. Now, several months after the earthquake, they feel they are in a position to make a series of statements about the prospects for earthquake prediction.

First, seismologists studying microseismic activity feel that by elaborate analyses of the waves generated, they may be able to distinguish true foreshocks, which occur in highly strained rocks, from normal low-level seismicity. Also, foreshocks may have a distinctive pattern, in both time and space, which has escaped previous detection. Scientists studying small changes in the earth's magnetic field feel that they may be able to predict abrupt creep events, but it is still unclear how these events might be related to an actual earthquake, if at all. Work also continues on the creep events themselves to see if they may actually propagate along the fault and serve to trigger earthquakes. Other workers, looking closely at the tilts and deformation of the ground surface, most of which result from tidal forces, find anomalous results that may have pointed exactly to the time and place of the earthquake. Closely related to the tilts are the observed changes in water levels and flows. Indeed, many workers feel that a close watch on the tilts and changes in the water level in large reservoirs may turn out to be the best prediction scheme.

Returning now to the real world, we see that although we are far from being able to forecast an earthquake at this time, the prospects for the future are good. Actually, an earthquake such as the one described has not occurred recently (although it could at any moment), but several smaller tremors have enabled seismologists to reach the stage of understanding implied in the last paragraph. Work in all the areas mentioned continues, and some of the "mays" will become firmer with time. More tests of the implied prediction schemes are, of course, required. These tests will require a large earthquake, thus putting seismologists in the unhappy position of having to live near an active fault while hoping for a major earthquake to take place. (It should be pointed out that the earthquake described above is only one of several possible types, and agreement on the processes and events leading up to it would be far from complete.)

Although it may appear presumptuous to think of preventing earthquakes when we cannot as yet even predict one, in certain cases there is some hope along these lines. The prevention problem has two facets. First, we want to prevent triggering earthquakes in areas where they would not normally occur and, secondly, we might want to try to prevent or modify the incidence of earthquakes in areas where they are almost sure to occur if nothing is done. In the second case, however, we should note that the enormous forces underlying most earthquakes cannot be turned off or resisted forever, so the word *modification* is perhaps better than *prevention*.

That man's activities can be the direct cause of earthquakes is now clear. Frequently the impounding of rivers to create large artificial lakes is the cause of an increase in local seismicity. The filling of reservoirs in Greece and southern Africa has produced earthquakes of significant size. During the ten years following the filling of Lake Mead on the Colorado River, more than 600 small, local tremors were recorded. That such effects can be disastrous is well illustrated by the events in southern India, where a large dam was constructed on the Koyna River in the extremely low-seismic area of the Deccan Traps. For several years following the impounding of the river, a definite increase in low-level seismicity was noted that could be correlated with the amount of water in the reservoir. Finally, in December of 1967, following an extended period of high water levels, a large earthquake occurred, killing 200 people and causing widespread destruction. Earthquakes such as this may result from an increase in the pressure of the fluids in the pores of nearby rocks. Whatever the cause, it is clear that the choice of a site for a large dam is not simple in terms of the seismic risk involved. At present there seems to be no reliable way to accurately predict just what effect a large dam will have on local seismicity.

Although it is possible that an increase in pore-fluid pressure near large reservoirs is responsible for producing some earthquakes, it is just this effect that holds some hope for modifying other quakes. The critical importance of the pore-fluid pressure in rocks near an existing or incipient fault is clearly demonstrated by experiences in Colorado. In 1962 the U.S. Army Corps of Engineers began the high-pressure pumping of waste fluids down a deep well at the Rocky Mountain Arsenal near Denver. Between 1962 and 1967 (when the fluid injection was stopped) there was a definite correlation between the number of local earthquakes and the volume of fluids pumped down the well and into the surrounding rocks. The earthquakes have continued ever since.

The effect of the fluids can be pictured as follows. For slippage to occur along a fault surface, a certain ratio—depending on the rocks involved—between the shearing forces parallel to the fault and the forces perpendicular to the fault must be exceeded. The greater the perpendicular forces, the greater the shearing forces must be to cause active faulting. To see how this works, simply place a tin can on a flat board and note how much harder you have to pull (shearing force) to make it slide if there is a weight on top. (You can measure the force needed by using a rubber band to do the pulling—the greater the stretch, the greater the force you are applying.) Now if the rocks on either side of the fault contain a pore fluid (usually water), there is lubrication at the joint, and the effective force perpendicular to the fault surface is reduced. But the shearing forces are not. Thus, less shearing force is needed to cause slippage. To see how this works with your tin can, repeat the same experiment twice—first with the can full of water and then with a small hole in the bottom so that a bit of water is trapped between the board and the rim of the can's bottom.

Presumably the high-pressure pumping of fluids down the disposal well at Denver lowered the perpendicular forces enough so that the pre-existing shearing forces were sufficient to cause slippage along the numerous old fault surfaces in the rocks around the well. Thus the earthquakes occurred. The U.S. Geological Survey has recently confirmed this hypothesis by a detailed series of experiments in an operating Colorado oil field. The experimenters made use of the normal procedure of pumping water down wells to increase the amount of oil recovered.

Citing the results of high-pressure pumping in Colorado, some scientists have proposed that the pore-fluid pressure in rocks near active faults could be modified, causing the release of the stored strain energy in a relatively safe and controlled way, rather than waiting for a natural and perhaps large earthquake to do the same task. One proposal goes as follows. A series of wells, say five, would be drilled in a line paralleling an active fault in an area where there are indications of a strain buildup. Fluids would be pumped out of all but the center well, thus strengthening the fault's resistance to slippage in those areas. Fluids would then be pumped down the center well, causing slippage (earthquakes) to occur. The faulting would, however, be contained in a small area by the neighboring zones of high strength, thus serving to release the stored strain energy near the center well in a controlled way. If the process proved successful, it could then be extended to other areas along the fault until enough energy was released to minimize the chance of a large natural earthquake. It probably won't be too long before such an experiment is tried (and it is an experiment). I, for one, am glad not to have the responsibility for carrying it out.

Other proposals for the release of stored strain energy are based on observations of underground nuclear bomb tests. Detailed analyses of the waves generated by these tests, together with the occurrence of aftershocks, indicate that more energy has been released than the bomb itself can account for. Thus it has been suggested that such blasts could be used to relieve strains built up near active faults. In addition to being completely uncontrolled with respect to the amount of extra energy released, this proposal has other obvious difficulties. It is not hard to imagine an underground blast triggering a great earthquake with an energy perhaps 100 times as great as the bomb itself. This is particularly true in such areas as the Aleutian Islands, site of a nuclear test program, where the natural seismicity is much greater than normal. Although any large earthquake generated in that region would have only limited direct effects on humans (not considering fish and wildlife), there is the distinct possibility that a large tsunami, or tidal wave, would be produced. The great Alaskan earthquake of 1964 generated just such a tsunami, which caused extensive damage to areas along the northern California coast.

Another problem—one which we should perhaps touch on briefly—is what would actually happen if an earthquake prediction were issued. It is only too easy to imagine the results in a large city following the announcement that a large earthquake was about to occur (and it is likely that no more than a few hours warning will be possible). Clearly, if this stage is ever reached, much more work, along lines other than purely seismologic, will be needed.

Near Saugus, California, another unfinished overpass, about five miles from the epicenter, collapsed during the February earthquake.

Sky Reporter by John P. Wiley, Jr.

The moon is nothing
But a circumambulatory aphrodisiac
Divinely subsidized to provoke the world
Into a rising birth rate

Christopher Fry, "The Lady's Not for Burning"

Water on the Moon In the future, lovers may have an alternative that will make life very difficult for songwriters: spooning in June by the light of the silvery Earth. The barren wastelands of the moon may be sitting on underground pools of water, a development that could radically change the outlook for eventual colonization, tourism, and, inevitably, honeymooning.

This evidence for water, the first that we have, is still on the iffy side. Instruments left on the moon by the Apollo 12 and 14 crews have recorded the outburst of geysers, spouting what apparently was water. The 14-hour eruptions occurred last March 7, but the scientists checked and rechecked their data for six months before saying anything.

The eruptions coincided with a series of small moonquakes. The water vapor spread out to cover an area of 100 square miles. Other, smaller geysers have been recorded since, but it is not clear that water was a constituent of these.

The instruments that identified the water are ion detectors, which react to the presence of ions, or charged particles, and which, in addition to identifying them, can measure their quantity and direction. The detectors were left on the moon to study ions arriving at the moon, any traces of lunar atmosphere, and any sign of volcanic processes on the moon. For those 14 hours last March, the detectors radioed back data that fit laboratory measurements of water vapor better than they fit anything else. Ammonia, neon, and other rare gases may also have been present.

The scientists who reported the findings, John W. Freeman, Jr., and H. Kent Hills of Rice University, said they were sure the water vapor was not related to the lift-off of the Apollo 14 vehicle from the moon. The outburst was detected 29 days after the spacecraft departed. They also discount a volcanic eruption as the explanation; if that had happened, they say, they should have detected such typical volcanic gases as sulfur dioxide.

Other scientists have been slow to accept the ion detectors' data as solid evidence for water on the moon, but they admit that it is not impossible. Geologists, who have yet to find any mineral evidence for water on the moon, quickly add that they have samples from only four, rather small areas.

For several decades, earthbound observers have been noting apparent eruptions on the moon, known as "transient lunar phenomena." These were believed to be ventings of gases from the lunar interior. If these gases do include water vapor, the moon may be far more hospitable than anyone has thought for years.

Tremors on the Moon Three seismometers are now measuring quakes on the moon, and so far there has been a lot of activity.

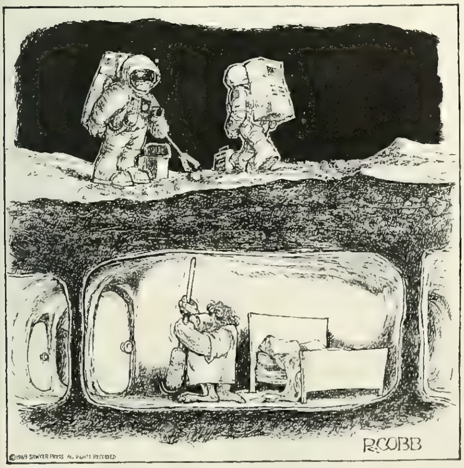
Some of the quakes appear to be the result of meteoroids slamming into the lunar surface, unslowed by any atmosphere. But many more can be called true moonquakes, vibrations set up by sudden movements in the moon's interior. Most are small by earth standards: they measure 1 to 2 on the Richter scale, which means you would be hard-pressed to feel them even if you were standing on the epicenter. But they are true quakes; the moon is not so dead as some would have had it.

Reporting at length in *Science*, Gary Latham of the Lamont-Doherty Geological Observatory and eight coauthors say they have located ten different zones on the moon where quakes appear to originate. Most of the activity occurs in one of these zones, a line running approximately north–south that crosses the crater Copernicus and passes between the Apollo 12 and 14 landing sites.

Because many of the quakes occur when the moon

is nearest the earth in its orbit, they are apparently triggered by tidal stresses. Knowing how strain is released, however, does not tell us how the strain comes to exist in the first place. Latham and his colleagues suggest several possibilities: slight expansion or contraction resulting from heating or cooling; gradual changing of the moon's shape from an ellipsoid to a more spherical form as the moon recedes from the earth and its gravitational muscle; localized strains from unsupported masses (the mass concentrations, or "mascons," that may be asteroid-sized chunks of heavy material buried beneath lunar seas); localized strains established as the moon readjusts following heavy impacts; or local heat sources.

The authors conclude that the moon is seismically active, but at a very low level compared with the earth. It is most unlikely, they feel, that any convection currents of the type that drag continents around on the earth exist beneath the lunar surface. They believe that, compared with the earth, the outer surface of the moon is cold, rigid, and stable, except for the minor disruptions associated with tidal forces. But they would like very much to know what causes the internal strains that make moonquakes possible.



Addendum by Thomas D. Nicholson

Shadow on the Moon Of the four eclipses that will occur during 1972, three will be at least partially visible in North America. The first of these will be the total lunar eclipse of January 30. While the beginning of the eclipse and the period of totality will be observable throughout the United States, the moon will set in the eastern United States while still emerging from the earth's shadow, before the end of the eclipse. The eclipse begins shortly after midnight on the West Coast, but just a few hours before dawn on the East Coast. The times for important stages of the eclipse are given below:

4:11 A.M., EST:	Eclipse begins, left edge of moon first enters earth's shadow.
5:35 A.M., EST:	Total eclipse begins, moon is completely immersed in shadow.
5:53 A.M., EST:	Mid-eclipse.
6:11 A.M., EST:	Total eclipse ends, moon begins to move out of earth's shadow.
7:35 A.M., EST:	Eclipse ends, moon leaves earth's shadow completely.

The above times will be one hour earlier in each time zone to the west.

In observing the eclipse, remember that the moon will appear to be moving westward (to the right) and closer to the horizon as the event progresses. This motion is caused by the earth's rotation. But the moon itself is moving to the east (left) around the earth. Therefore, the left edge of the moon enters the shadow first, and the shadow seems to move across the moon from left to right, while at the same time, the moon moves downward and to the right toward the horizon.

Note particularly the curved shape of the shadow's edge (one of the early "proofs" that the earth was round), the variation in the density of the earth's shadow as it progresses across the moon, and the color and shading of the shadow during total eclipse.

Celestial Events

by Thomas D. Nicholson

After new moon on January 16, the moon enters the evening sky, reaches first-quarter on the 23rd, and becomes full on the 30th. In the morning sky during the first half of February, the moon is at last-quarter on the 7th, and it becomes new again on the 14th.

Venus, Mars, and Saturn are evening stars during late January and early February; Jupiter is becoming more prominent as a morning star. In the evening sky, Venus is brightest, low in the southwest at dusk and setting shortly after dark. Mars is higher in the southwest after dark and sets before midnight. Saturn, well up in the southeast in the early evening, sets in the west before dawn. In the morning sky, Jupiter rises before dawn and disappears into the early twilight.

January 16: The first of this year's two solar eclipses occurs today; the second, more interesting locally, will occur on July 10.

The eclipse of January 16 will be annular over parts of Antarctica and the southern Indian Ocean, while the associated partial eclipse will occur over southern Africa and extreme southwestern Australia. During an annular eclipse, the moon's distance from earth exceeds the length of its shadow, so that the shadow tip does not actually touch the earth's surface. In the sky, the moon moves centrally across the sun, but it is not large enough to cover the sun completely. A ring, or annulus, of the sun remains visible around the moon at mid-eclipse.

The second solar eclipse of 1972, on July 10, will be visible as a partial eclipse throughout North America, and will be total in a narrow band crossing northern Alaska and northern and eastern Canada. The path of totality in eastern Canada will be readily accessible to residents of the northeastern United States.

January 18-19: The planet near the crescent moon on these evenings is Venus: to the left of the moon on the evening of the 18th; to the right, below, and more distant from the moon on the evening of the 19th.

January 21-22: The moon passes above Mars during the morning of the 22nd. The planet will be to the left and below the moon in the evening sky of the 21st, to the right and below the moon on the 22nd.

January 25: The bright object below the gibbous moon this evening is Saturn. During the night, the moon approaches more closely to Saturn as it passes north of the planet.

January 30: A total lunar eclipse will be visible throughout North America during the early morning hours today (*see page 47*).

January 31: Saturn is stationary and resumes its direct (eastward) motion among the stars of Taurus.

February 9: The reddish star near the crescent moon this morning is Antares, in Scorpius.

February 10-11: Jupiter is found near the crescent moon on these two mornings. On the 10th, the planet is to the left and below the moon in the southeast. On the morning of the 11th, Jupiter is to the right and above the moon.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:20 P.M. on January 15; 9:15 P.M. on January 31; and 8:15 P.M. on February 15; but it can be used for about an hour before and after those times.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Eltanin
DRACO
BIG DIPPER
Kochab
LITTLE DIPPER
Polaris
Megrez
Dubhe
Merak
URSA MAJOR
CEPHEUS
Caph
CASSIOPEIA
CAMELOPARDALIS
ANDROMEDA
Schedar
Alpheratz
PEGASUS
Algenib
Almach
Mirach
LYNX
Capella
PERSEUS
AURIGA
PLEIADES
ARIES
Hamal
PISCES
Mars
January 21
January 23
Castor
Pollux
GEMINI
January 27
TAURUS
Saturn
Aldebaran
Bellatrix
Betelgeus
ORION
Procyon
CETUS
Rigel
Saiph
ERIDANUS
Sirius
LEPUS
CANIS MAJOR
PUPPIS

The Mysterious Wolf of the South

Little is known about the life history of the red wolf. Now it looks as if we may never have the chance to find out

When white settlers first entered southeastern North America, they encountered large, wolflike animals in the region from central Texas to Florida and north to the Ohio River Valley. These animals, mentioned in writings dating back more than 300 years, were still common in certain areas until the early twentieth century, but they remained little known to science. Now, after centuries of human persecution and environmental disruption, the native wolf population of the southeast has become nearly extinct. Possibly these animals will disappear entirely before their taxonomy and life history are known.

The term *red wolf* was originally used in reference to animals that lived in central and southern Texas. But taxonomic studies later showed a consistency of key cranial and dental features between these animals and the wolves that lived across the southeastern states to Florida. Thus the designation *red wolf* and the latinized name *Canis rufus* came to be applied to all wolflike animals in this region.

Unfortunately, the red wolf was exterminated from most of its original range, particularly in the east, at an early date. Few specimens were preserved, and there were no really complete descriptions of the animal's appearance and life history. Therefore we do not know exactly what sort of animal the red wolf was under natural conditions, and whether it was more closely related in habits and physical features to the larger gray, or timber, wolf (*Canis lupus*), which existed to the north and west, or to the smaller coyote (*Canis latrans*) of western North America.

Even the common name red wolf is misleading although we continue to use it for convenience' sake. The reddish color referred to was not particularly common except in parts of south–central Texas. Available specimens, plus literary accounts, show that from eastern Texas to the Atlantic there once lived black, brown, grayish, yellowish, and red wolves. Thus, size and body structure are better guides than coloration for distinguishing the different species of wolves.

Some 213 adult red wolf skulls collected in the south–central part of the species' range show that almost every red wolf was considerably larger than the largest coyote, but that the majority were smaller than most gray wolves. In the region represented by these specimens various accounts indicate that female red wolves usually weighed from 40 to 60 pounds, males from 55 to 75 pounds. Some larger animals were reported, and one 92-pounder from Winn Parish, Louisiana, seems to be the record.

The accounts of early settlers and naturalists invariably refer to the wolflike animals from extreme eastern Texas to Florida as "wolves," showing that they considered these animals to most closely resemble the gray wolves of Europe and northeastern North America. Nevertheless, some reports from the coastal area of Texas use red wolf synonymously with big coyote.

Early and recent accounts from Texas agree that the red wolf was more slender and had relatively longer legs than the gray wolf. Such proportions are believed to have been an adaptation for long-distance running. It has also been suggested that the species' long, slender legs enabled it to get along better in the coastal prairies and river bottom swamps where it was especially abundant.

The mystery of the red wolf's identity is emphasized by the fact that while some workers believe it to be very closely related to the coyote, one recent taxonomic study at Harvard University indicated that it was actually a subspecies of the gray wolf. This latter investigation attempted to draw up a mathematical definition of the red wolf based on skull measurements. Other studies, using brain anatomy and blood serum analysis, have tried to define the red wolf as a distinct species. An idea that now seems to be emerging is that the red wolf represents the surviving stock of a primitive line of wolves that occupied much of North America a million years ago, but was then forced back by more advanced animals and changing environments into a range centered in the great swamps and marshes of the southeast.

Specific details of the ecology, reproduction, and behavior of the red wolf are very poorly known. No significant studies were made when the species was still prevalent, and recent efforts have been limited by the problem of locating definite red wolf populations. Possibly we will never know how this animal lived under natural conditions in an undisturbed habitat. What is known has been derived by combining information from old accounts and from new studies in southeastern Texas.

Red wolves establish dens in hollow tree trunks, stream banks, old holes of other animals, and, in

by Ronald M. Nowak

coastal areas, on sand knolls. Although usually obscured by brush or vines, the dens' locations give the occupants a good view of surrounding terrain.

The young are born from late March to May, following a gestation period of 60 to 63 days. Both parents actively guard and feed the pups. The young reportedly number from 3 to 12, with 6 or 7 being average, but most die before the age of six months. Hookworms are said to be a major factor in keeping the successful reproductive rate low in southeastern Texas. Full size and mating capability are attained in the third year of life, but surviving young usually remain with the parents for a longer period.

Many observations attest to the highly social character of the red wolf, with at least two animals reported in most accounts of sight-

ings. The original parents and surviving pups for several successive years form most of the so-called packs, although occasionally, different family groups join together. A pack usually includes from 5 to 12 individuals, but as many as 23 have been seen together.

The red wolf is noted for its long-distance movements. An adult pair or pack is said to establish a roughly circular territory through which the animals move about once every seven days, often on definite runways. Many years ago, some packs reportedly had territories 40 miles in diameter, but most were certainly smaller. A number of accounts expressed the belief that red wolves in the Gulf Coast area concentrated on the coastal prairies in fall and winter, and moved to the inland forests in spring and summer.

Clearly the red wolf was not so much a predator of big game as was the larger gray wolf. There are stories of packs of red wolves pursuing deer, but the species was not always dependent on such activity, and usually smaller animals are referred to in accounts of the red wolf's prey. The only systematic analysis of stomachs of animals presumed to be red wolves showed that rabbits and hares made up the highest percentage of food taken, with small rodents ranking second. Other reported natural food of the red wolf includes squirrels, muskrats, nutria, prairie chickens, waterfowl, fish, crabs, crayfish, insects, and vegetable matter.

Records of predation on domestic animals are, of course, very common. Again, it appears that the red wolf did not share the destructive ability of the large western gray wolves, which were said to be capable of individually bringing down full-grown steers. There are a few tales of groups of red wolves attacking adult cattle, but such cases do not seem to have been usual. Reports of predation generally refer to calves, small hogs, sheep, and poultry.

In the early 1900s, wolves were said to have made sheep raising difficult in the Big Thicket of Hardin County, Texas, and in parts of northeastern Louisiana. There, and in other lowland areas of the South, the practice of allowing hogs to wander freely in the forest led to many claims against the wolf. Surprisingly, the wolves of Texas and Louisiana also reportedly took a heavy toll of domestic dogs. When dogs were used to hunt the wolves, the latter often turned the tables as soon as the opportunity arose.

The red wolf was never a threat to human life; even the earliest accounts attest to this fact. Audubon did write of a slave killed by a pack of wolves in Kentucky in the early nineteenth century, but this is the only instance recorded in which red wolves may have been directly responsible for a human death. Following battles of the American Revolution and the 1835 Texas Rebellion, wolves were said to have fed upon the dead, but the animals reportedly fled at the approach of a living man. From throughout the southeast come many tales of wolves following or pursuing humans, although an actual attack seldom occurred, and such cases were often attributable to freshly killed game being carried by the person involved.

The exact limits of the red wolf's original distribution, particularly in the north, will probably always remain a mystery. Wolves were exterminated at an early date in a broad swath from Pennsylvania through the Ohio Valley to northern Missouri, with very few specimens saved. Since none of the early accounts from this region attempts to distinguish between the red and gray wolf, we cannot be sure where the range of each species stopped.

The decline of the red wolf began with the arrival of white settlers along the Atlantic coast. The course

of events in South Carolina is typical. Here, in 1695, the colonial assembly ratified "An Act for Destroying Beasts of Prey." By this measure every Indian bowman was required to yearly bring in one wolf, panther, or bear skin, or two bobcat skins. If the Indian produced more than one skin, a reward was provided, but if he failed to get his quota, he was to be "severely whipped." Regular monetary bounty payments began in 1700 and continued for most of the period through the end of the eighteenth century when wolves were noticeably on the decline.

The animals were often trapped by means of baited pits, dug about ten feet deep. Above the pit, fresh meat was suspended over a balanced board that dumped the wolf into the pit when it reached for the bait. Variations of such traps were later used over much of the southeast.

By 1850 the wolf was said to be nearly extinct in South Carolina, and the last reliable records are from the lower Santee River bottoms between 1856 and 1860. A few twentieth-century reports of wolves in South Carolina are attributable to introduced animals.

The early extermination of wolves on the Atlantic seaboard was the result of an ancient attitude. Striking out of the river swamps, their howls piercing the night, these animals probably seemed like devils incarnate to the early settler with his European background. Certainly the actual depredations on livestock were inconsequential when compared to losses suffered through flooding and disease, but perhaps nothing infuriated the farmer more than the sight of a sheep or hog torn apart by wild beasts. While the settler was helpless against the other forces of nature, the predator offered him a chance to strike back.

As "civilization" moved westward, the steel spring trap succeeded the pit as a primary method of catching wolves. Poison was also widely used beginning in the mid-nineteenth century. Another common means of destruction was locating and killing young wolves in the den.

In some parts of the southeast, the Civil War served as a respite for the wolf, but following the end of hostilities, the species was extirpated over wide areas. Wolves reportedly held out in the mountains of North Carolina and Virginia until the first decade of the twentieth century, but we cannot be sure that these animals were red wolves. The forests of southern Indiana and Illinois apparently sheltered a few surviving red wolves until the early 1900s.

The remote lowlands of Florida and southern Georgia were among the last refuges for the red wolf in the east. Severe depredations on calves and sheep were reported during the closing years of the nineteenth century, but strychnine poisoning made the species rare even here after 1900. A few wolves reportedly survived until about 1920 in the Everglades, along the Kissimmee River of Florida, and in the Okefenokee Swamp of Georgia. Except for an occasional wandering individual, by the 1920s the red wolf had been exterminated in the entire region east of the Mississippi River. The species had also vanished from southeastern Kansas and central Oklahoma, and from most of its former range in Texas.

There remained two large concentrations of red wolves: one centered in the Ozark-Ouachita uplands of Arkansas, eastern Oklahoma, and southern Missouri; the other in the river bottom forests and coastal prairies of Louisiana and southeastern Texas.

But there were too many pressures on these last wolves. Various state and county governments in the region offered bounties. Trap-

Continued on page 74

The Glory of the Long-Distance Runner

by Michael Jenkinson

photographs by Karl Kernberger

In the rugged barranca country of Mexico's Sierra Madre Occidental, Tarahumara Indians compete in three-day marathons that may cover as much as 200 miles

Mile after mile in the blazing heat, runners in the *rarijipari* propel a wooden ball through the barranca country. Referees run with the teams to make sure strict rules of the race are observed.

In the Sierra Madre Occidental of northwestern Mexico there is an Alice in Wonderland sort of region where mountains often rise so gently they seem almost flat and bottomlands appear perpendicular; where canyons carved by creeks seem deeper than the Grand Canyon of the Colorado; where fruit trees have houses; where owls may be no bigger than sparrows; and where running Indians leave tire-tread imprints on dusty trails.

Much of it is wild country, known only to the Indians who inhabit it. Years after the warriors of Cochise and Geronimo had laid down their rifles and been herded on to reservations, bands of nomadic Apaches roamed the Sierra Madre, skirmishing with Mexican soldiers who ventured into their wilderness stronghold. The last of these Apaches were annihilated by *federales* less than three decades ago. Today, most of this country, some 35,000 square miles of violently dissected terrain connected by rough trails, is the homeland of Tarahumara Indians. Speaking a form of Uto-Aztecan, these people are related linguistically to the Papagos of Arizona and the Huichol of Jalisco, as well as to many other tribes from Montana to Honduras.

The final tie for the Chihuahua al Pacifico railroad, which crosses the Sierra Madre, was spiked in 1961. The terrain yielded grudgingly to roadbed: in the short drop from continental divide to coastal plain, engineers were forced to blast 89 tunnels and construct 48 bridges. Now, old Pullman cars, swaying through the heart of the Sierra Madre, bear tourists who wear lapel name tags provided by tour directors and look up from canasta and conversation to see the wild country rolling by the windows.

Where the train stops, Indian children hawk drums, twilled baskets, or other items, while travelers snap photographs. Yet most of the inhabitants of the Tarahumara backcountry seem as remote from this train—this capsule of civilization—as tribesmen in the Amazon rain forest.

For some seventy miles west of Chihuahua the landscape is one of dry hills, where cattle browse between cactus clusters, and low stone walls, still used in lieu of barbed wire, recede into the distance. In scattered mud villages, men in straw hats squat in the shade before small stores: smoking, talking softly, gazing into the distance.

So gradual is the slope of Mexico's great central plateau that mountains are announced by forests rather than by pronounced foothills or distant peaks. Scrub oaks give way to tall ponderosa pines, *encinas* ("live oaks"), and gnarled madroños with bark the color of burgundy wine. Granite boulders push up between the trees. Where there are cleared farms, young fruit trees are protected from scavenging goats by logs piled around them like so many small, roofless huts.

In the highlands there are several logging towns, most of them astride the railroad. They are evocative of the frontier towns of the American West—dusty streets, log or frame buildings, horsemen and wagons, the smell of freshly cut lumber. Law enforcers, carrying guns at their hips, wear boots, western hats and shirts, and Levi's. Most other males who can afford pistols usually carry them tucked in their belts, covered by shirts or jackets. Forty-fives are favored and their use is not infrequent.

It is the canyons, the barrancas, that dominate the landscape of the Sierra Madre. The canyons of the rios Urique, Chinipas, Batopilas, and Verde (or San Miguel, as it is sometimes called) all appear to be deeper than the Grand Canyon. Precise depths are still unknown, for the region has never been thoroughly explored or mapped. Many deeply cut tributary canyons, which would warrant a national monument in the United States, are not even named.

On the canyon rims, ravens croak through pine forests. It has been known to snow in the late springtime, but by May, the sun beats off the cliffs and immense boulders in the bottoms of the barrancas, and when the wind dies they are like open forges. Flocks of parrots sweep over the bamboo thickets and the orange trees. Butterflies jiggle between kapok, laurel, and tamarind trees. On the sidehills, century plants, sotol, tree and ball cactus stand in the heat.

In the dry season, wooden plows are pulled by hand or oxen across dusty fields in the high country, and smoke from unchecked forest fires hazes the canyons. In the barrancas, the rivers are shallow, trivial, out of proportion to the deep trenches they have cut. In most places they can be waded.

From late June through September, however, thunderheads build in the heat of late morning, to explode in storm during the afternoon. Dry arroyos become sizable creeks, creeks swell quickly into rivers, and everywhere waterfalls plummet over ash-gray cliffs. In the bottoms of the largest barrancas, roiling masses of water pound through barricades of gigantic, polished boulders. Rocks the size of two-story buildings grind and shift with rumbles that cut through the incessant roaring of white water.

There are two old Spanish mining towns deep in the barrancas: Batopilas and Urique. They are self-contained, isolated places. Supplies are mostly brought in by burro trains from towns near the rims, thousands of feet above. Both villages have landing strips, and when the infrequent visitor arrives by aircraft—a government official, perhaps, or a mining engineer—the reception, especially among the excited children, is rather like that given a ship docking at a seldom-visited South Sea island port. The lack of air travel to these places, except for pressing business, is understandable. The airstrip at Urique, for example, is a narrow, rocky track that pitches downhill at a slope only slightly less inclined than that of a barn roof. An ancient

walled cemetery at the end of the strip seems conveniently located.

When villagers of Urique or Batopilas do make a journey, they follow switchbacking trails up to the canyon rim, and then possibly take a train to Chihuahua. For these Mexicans, the rest of the barranca country is mostly unknown, a wilderness.

Occasionally, backpackers head down into the canyons, following Indian trails, but this can be tricky, as the paths are faint and fork frequently. One tequila-belting group of Chihuahua students lost their path in the dusk, and ended up dozing fretfully all night astride weird tropical trees that grow out almost horizontally from precipitous slopes.

Some of the many trails in the barrancas country are rough but passable for burros or mules; others are scarcely more than goat paths that traverse harrowing ledges and thorny slopes. Over these the Tarahumara Indians stride easily in sandals with soles made from discarded truck tires. Frequently the journey is to a friend or relative's dwelling, which might be a log and stone structure, a lean-to, or a cave. Caves also serve as goat pens and burial places. For the most part, Tarahumaras tend to live in isolated family units rather than villages.

Eventually, if the right turns are made, the path will lead to a high-country trading post or a Mexican village. Sometimes the Tarahumaras will bring things out of the canyon—drums, violins, calcite crystals, coati skins, bearded ceremonial masks, bamboo flutes—hoping to sell them to tourists when the train stops. The violins are carved with great care and ritual from native woods, principally ash, and put together with glue that is derived from a lily bulb. There is a Tarahumara word for each part of the instrument.

On occasion, an Indian will approach a trader he trusts with some gold dust tied in a bandana or a bit of rag. The traders know better than to ask from where it comes; the Indian would merely mumble, "From the barrancas," and his face would become expressionless. In the past, Tarahumaras who showed Spaniards and Mexicans the sources of gold ended up dead or slaving out their lives in dim tunnels.

Sometimes whole families go to Mexican villages just to look. Women and girls in bright red dresses; men in cotton pullovers, headbands, and a sort of loincloth peer through the open doorways of *tiendas* ("shops"), where canned goods are stacked in rows of bright cylinders. Food is hard to come by in the barrancas. *Pinol*, a cornmeal mush, is the main staple, supplemented by some wild game and occasionally the meat of domesticated animals. In addition to corn, the Indians grow beans and squash in small plots, sometimes on slopes so steep that it appears difficult to stand upright on them, much less engage in cultivation.

Runners take turns flipping the hard ball with their feet. Team members use sticks to maneuver the ball toward the kicker. Touching it with the hands is forbidden.

Although domestic plants make up the bulk of his diet, the Tarahumara is a constant, sharp-eyed forager. Numerous wild plants and roots are gathered for food, seasoning, medicine, and ceremonial purposes. Wild onions and mustard greens, for example, are welcome additions to a family's meal. The soft center of ball cactus is squeezed into the ear of a person afflicted with earache or deafness.

With a frail bow and wood-tipped arrows, the Indians occasionally hunt deer or peccary. More frequently, rabbits, pack rats, squirrels, skunks, chipmunks, ducks, quail, and other small game are brought down with a well-thrown stone. A strong throwing arm is also good for knocking honeycombs out of cracks in the cliffs. Snares are set for gophers; rock deadfalls for mountain lions. Lizards, considered delicacies, are caught by hand and rattlesnakes are also eaten.

Snakebite cures include blowing smoke into the victim's face, giving him peyote buttons to eat, and holding the snake while he bites it back.

There are trout in the high-country ponds, and the rivers of the barrancas contain bullhead catfish, mountain suckers, squawfish, and other species, some of which are found nowhere else. Tarahumaras stun the fish, using several of the many narcotic plants that grow in the region. A substance is stirred into a quiet pool with a stick; soon, groggy fish float up to the surface where they can be grabbed with the hands. Certain plants, such as a type of agave and poison hemlock, are used in running water because their potency carries as far as 300 yards downstream.

The Tarahumaras "fish with thunder" when they can obtain dynamite sticks from Mexican miners. The sticks are lobbed into larger pools, and if the timing is right, the explosion sends a column of water into the air, sometimes tearing slabs of rock loose from the cliffs above. Dead and dying fish are scooped up, split down the backbone for cleaning, and either roasted over coals on the spot or dried on rocks for later consumption. The "thunder sticks," of course, kill fingerlings as well as larger fish, and their continued use will, no doubt, eventually eradicate any sort of river life in the barrancas. Ecology, however, is not a prime concern to a man who may not have eaten for the past twenty-four hours.

Virtually the only animal life not considered potential food by the Tarahumaras are bears and bats. Except for those few Indians who own old Mauser rifles or have been fortunate enough to get hold of newer ones, the hunters' weapons are inadequate to kill a bear. More importantly, a bear is considered to have ancestral ties and power, and elderly Indians often refer to it as "grandfather."

Also, among Tarahumaras it is believed the dead awaken at night and may swoop about in the form of bats. In daylight, the dead may take the form of butterflies, and from the wing markings, a shaman can sometimes interpret the identity of the human or animal spirit thus liberated.

Tarahumara wealth is measured in cattle, sheep, and goats, but most Indians are poor and only possess small flocks of goats. These animals are rarely sold and are generally eaten only at special feasts occasioned by a house raising, a major footrace, a church fiesta, or a curing ceremony. Curing ceremonies are conducted by shamans who may be called upon to exorcise the spirits that cause illness or drought or to drive away evil influences at the time of crop planting, death, or birth.

Spaniards penetrating the barrancas country early in the seventeenth century sought both silver lodes and Catholic converts. Jose Pascual, a Jesuit priest, established the first Tarahumara mission in 1639. Today there are Catholic churches scattered throughout Tarahumara country, some of them dating back more than two centuries. In remote areas that have not been visited by outside priests for decades, church services are conducted entirely by Indians, with an amalgam of Christian dogma and native beliefs. Undoubtedly, there are theologians who must muse unhappily at the irony of Tarahumara shamans periodically conducting ceremonies to purify the churches themselves.

There are approximately 35,000 Tarahumaras, occupying about an equal number of square miles. Because game and edible plants are sparse, crop failure often means starvation. Only one out of five Tarahumara babies lives to age five; the rest succumb to malnutrition and disease.

The Indians who do survive in this harsh yet bewilderingly beautiful landscape are short, wiry, and possessed of incredible endurance. Women from small settlements deep in the barrancas, such as San Luis and Divisadero, frequently walk to Chihuahua and occasionally even to Ciudad Juárez, infants in shawls on their backs. The Juárez trek is roughly equivalent to a hike from Phoenix to Los Angeles, or about 400 miles, and in places the Chihuahua desert presents almost as sere a landscape as the Mohave in Arizona and California.

Tarahumara hunters literally run deer into the ground. Once on the track of a deer, a man or several men will continue to jog after it for

Women watch as men of the tiny Indian settlement of San Luis line up for a three-day-long procession held in honor of local saints during Holy Week. By the last day, the pace of the procession increases to fever pitch as the men race madly around the church

hours, rarely in sight of the prey, skillfully reading the most minute signs. By the second day of steady chase, the fleet animal usually drops, exhausted, and the hunters kill it with knives or rocks.

Recently, a Tarahumara courier was dispatched from the Jesuit mission center at Sisoguichic to assess food supplies in several Indian hamlets. He was said to have covered fifty miles of rough mountain trails in six hours—including the stops at each hamlet. Forty years ago, a Tarahumara chief was invited to send runners to a marathon in Kansas. Learning, to his great surprise, that the course was to be a mere 26 miles, the chief sent three girls.

Tarahumara running ability appears to stem from a combination of biological and cultural factors. Tests indicate that many of these people have low blood pressure and pulse rates. From childhood, women spend much of their time scrambling up hillsides after goats; men hunt and engage in running games. Houses are often distant from fields, water supplies, and neighbors. The rugged terrain provides constant conditioning. Probably most important, however, is that running is encouraged in Tarahumara society. One way for a man to attain great prestige is by

excelling in this particular activity.

The Tarahumaras may be the finest natural distance runners in the world. Yet when taken out of their natural environment, performance pales, just as does that of the gifted high jumpers of central Africa when they do not leap from rounded, cement-hard anthills. Although there were some Tarahumara runners on the 1928 Mexican Olympic team, and others have more recently been persuaded to try out for international competitions, the results have not been dramatic.

For one thing, there is the matter of diet. The Tarahumara lives mostly on corn gruel in the mountains. When he comes to an Olympic training camp, he is given beefsteaks to eat and his gaunt gut is filled with eggs and milk and other strange food. His metabolism begins to run crazy. He doesn't sleep

Goats flee as runners race across the rim of La Barranca del Cobre. At the bottom of this canyon, the Rio Urique winds its way through remote Tarahumara country.

With equal exuberance, wome right, compete in a shorter version of the men's race, substituting a hoop flung with a stick for the wooden ball. Left, two runners take a well-earned break between la

much and when he does, he has weird dreams.

Then there is the matter of where he runs. In the mountains he is always loping up rocky hillsides and then plunging down again; there are logs to be hopped and flocks of goats to be skirted. Here, at the training camp, one just runs around in a circle. Nice grass inside, but still a circle. Round and round. It soon gets boring.

And there are always people watching: at the important races, concrete mountainsides of spectators, shrieking and yelling at the top of their lungs. For a Tarahumara, who has a doelike shyness with any but his own people, it is a terrifying situation.

Finally, then, there is the matter of footwear. A Tarahumara's feet are splayed out from constant, unconfined use, broad, with deep permanent cracks in brown soles. All his life he has worn sandals, tire tread lashed to bare feet with thongs. At Olympic track meets he is expected to push his feet into confining leather shoes, some even have cleats like hard shiny cactus spines on the soles.

No, running in shoes is about as appealing to a Tarahumara as competing in a gunny sack would be to an American athlete. But back in the mountains, without medals and only a few of the weird dreams still lingering, the Tarahumara runners again compete in tribal games, running for miles through wild country where birds dart up against the sun and canyons drop away into haze and grandeur.

The most popular and elaborate Tarahumara sport is called *rarijipari*, a sort of marathon kickball race. The top runners of a district, locally known as an *ejido*, compete as a team against the best competition another *ejido* can put up. The *ejido* chiefs determine the course, marking it with crosses cut into the bark of trees along the way. Individual laps may vary from three miles to twelve, while the entire contest may last for three days and cover up to 200 miles. At night, the runners carry pine torches to light their way.

On occasion, short races of fifty miles or so have been staged for anthropologists or other visitors. At one such abbreviated affair, it was discovered that two quarts of tequila promised by the sponsor had been overlooked in a flurry of barbecue preparations. One of the runners made a loping beeline over the hills for eight miles to the nearest source, returned with the bottles and, after throwing back a couple of stiff ones, was ready for the race.

Major *rarijiparis* are not taken lightly. As the event draws near, spirited wagers are made, sometimes with money, but more often with cattle, sheep, goats, drums, flutes, clothing, or other personal effects. Since most Tarahumaras are poor and the betting may be heavy, the outcome of a race can drastically deplete or increase a bettor's assets.

For a period of two to five days before a contest, runners avoid contact with women, and are careful not to eat fat, eggs, potatoes, or sweets. *Tesguino*, a drink made from fermented corn sprouts, is forbidden, although gallons of it are brewed for the upcoming festivities. The runners' legs are rubbed with smooth stones and oil and brushed with herbs and boiled cedar branches.

Magic is used too. Once the kickballs, which are about the size of a grapefruit, have been carved from madroño wood, a shaman takes them to a burial cave. The shinbone of a man's right leg is exhumed. The bone, the wooden balls, bowls of food, and a jar of *tesguino* are set before a cross, and the spirit of the dead man is asked to cast a spell that will weaken the opponents. Other bones may be taken and secretly buried at certain places along the *rarijipari* course. Runners of the shaman's *ejido* are advised of those places, so they will not pass near them; hopefully runners of the other team, unaware, will become fatigued. The relics, the Tarahumara believe, can exert a powerful influence for a short distance.

The night before the race, candles are lighted on either side of a small wooden cross. The runners arrive, many with the fetishes they will wear to make them strong in the race: eagle feathers, hawk and vulture heads, glowworms, and rattles made of deer hooves. The sha-

man chants and sings the "song of the gray fox." The runners make ceremonial turns around the cross and candles, the exact number of laps they will run during the *rarijipari.* Then the runners wrap themselves in their blankets and are soon in deep, untroubled slumber, next to the food and water they will take at intervals throughout the race. Here, their opponents' magic cannot touch them, for the shaman will remain with them to protect them until dawn.

On the day of the race, excitement is at fever pitch as more and more Indians surge in from the backcountry. There are a number of small fires for cooking and for warmth. A certain amount of sly flirtation goes on (most Tarahumara girls, informally but permanently, acquire mates by the time they are fourteen or fifteen, when they normally develop a strong physical urge for a man), but generally the men tend to group together around different fires from the women. Gourds are dipped into cut-off oil drums filled with *tesguino.* Old friendships are renewed. Bets are made. There are flocks of goats everywhere, herded by tiny, barefooted girls who keep strays in line by lobbing stones at them with amazing accuracy.

Before the *rarijipari* gets under way, the governor of the home *ejido* may give final instructions, reminding the runners that anyone who throws his kickball by hand will not only be disqualified but will wind up in hell. The Tarahumara do believe in a nasty place where wrongdoers emerge after death. (When pressed for physical details about this place, they profess ignorance, saying no Tarahumaras have ever gone there. All they claim to know is that there is a devil with a bitchy wife, and that their numerous offspring are Mexicans.)

The teams start off. Only one runner at a given time kicks the carved globe; others carry bladed sticks with which they feed the ball toward him. Rather than actually kicking the wooden ball, which even for a Tarahumara's leathery foot would soon become toe-shattering, the runner slips his toes under the ball and flips it with his foot. Each team is accompanied by six referees who make certain that no

When darkness creeps over the barrancas, runners light pine torches coated with pitch. The race goes on all night, passing the photographer in a flaming streak.

shortcuts are used, no tripping or other foul play occurs, and that no runners are chewing the dried leaves and seeds of the *riwerame* plant. It is believed that the breath of a *riwerame* chewer, blown into an opponent's face, will cause the opponent to have the blind staggers within half a mile. Drunks, naturally, must be kept off the race course, and pregnant women, considered bad luck when it comes to matters like this, are kept from watching the runners. The life of a *rarijipari* referee is no easier than that of his counterpart in baseball.

The runners, jogging through darkness or through the heat of high noon, often chew peyote as a stimulant. At certain specified spots they stop for warm water and *pinol,* rest briefly, then continue on.

Along the course, people sleep, talk, and play violins and flutes. Fires glow in the night, and one must reach deep into the oil barrels to scoop out *tesguino.* Life's hardships, the struggle for survival, are briefly forgotten in laughter, music, and the mingling of people who share the same thoughts and places.

At the end of the race sometimes only one man is left, the others having fallen away in exhaustion. He receives no prize—only a small percentage of the bets.

Yet he will know, even when he is very old and half dozing in lost dreams, that he once did something better than anyone. For the Tarahumara, running is more than just self-satisfying; although it does not automatically lead to power or wealth, to excel in running is a major way to gain prestige.

Antarctic Fossils and the Reconstruction of Gondwanaland

Fossil remains show that the same animals roamed southern Africa and Antarctica 200 million years ago, more evidence that the southern continents were once a single land mass

by Edwin H. Colbert

At the present time geology is experiencing a revolution as profound as the one that shook biology a century ago, when Charles Darwin and Alfred Russel Wallace propounded the theory of evolution. This geologic revolution has to do with the theory of continental drift, which postulates that the continents have been mobile throughout the immensity of geologic time, rather than the stable elements they were so long thought to be. This is a revolutionary idea indeed, as the theory of organic evolution was a revolutionary idea. And as the theory of the evolution of life through natural selection gave man a new view of nature and of his place therein, so the theory of drifting continents has given man a new view of the earth on which he lives.

The idea of the evolution of life had been "in the air" for some decades before Darwin's *Origin of Species* was published in 1859. Likewise, the idea of drifting continents has been in the air for several decades—since the early years of this century and, in some respects, even before that. Darwin and Wallace independently gave initial form to the theory of evolution, but it was largely through the detailed and massive work of Darwin that the theory became established. Frank Taylor, an American, and Alfred Wegener, a German, independently gave initial form to the theory of continental drift, in 1910 and 1912, but it was largely through the efforts of Wegener and his brilliant follower Alex Du Toit of South Africa that the theory was developed in considerable detail.

For years, however, many, perhaps the majority of geologists throughout the world strongly opposed the theory of continental drift. Wegener and Du Toit were ahead of their time; they had the concept, but they lacked the hard facts to give it a convincing basis. Now, within the past decade or so, facts have come to light in varied disciplines that have made continental drift not only a viable, convincing theory, but an exciting one as well. Continental drift is gaining ever wider acceptance among geologists the world around, and the modern geologic revolution is succeeding in a dramatic way.

To be valid, a theory must explain more or less satisfactorily all aspects of the phenomena with which it is concerned. For many years, numerous paleontologists—the students of ancient life on the earth—were not impressed by the theory of continental drift because they did not need it to explain the distributions of fossils on the continents. This was particularly true for the fossils of land-living vertebrates, backboned animals that moved from one place to another by dry-land routes. Paleontologists could explain the distributions of such animals through geologic time by postulating intercontinental movements across existing land bridges or across those that existed in the relatively recent geologic past: namely, the Panamanian Isthmus between the two Americas; the Bering bridge (presently interrupted by the relatively narrow and shallow Bering Strait) between the Eastern and Western Hemispheres; and of course the connections between Africa and the lands to the north. Australia, an island continent, was supposed to have had former connections with Asia. New Zealand and Madagascar, large islands near continents, were supposedly colonized by land-living vertebrates that adventitiously drifted to these isolated regions on masses of floating vegetation or logs. Such routes and means explained the distributions of ancient and present-day amphibians, reptiles, and mammals on the land masses of the earth.

Students of land-living vertebrates, however, largely ignored one continent—the island continent of Antarctica. It is true that today the edges of Antarctica are populated by such vertebrate animals as seals and penguins, as well as a few other birds, but the presence of

Two members of the 1969–70 expedition work their way across the lower bone beds on Coalsack Bluff. The rock has been carved by wind-driven snow.

these denizens of ocean and shore is readily explained. Aside from such marginal inhabitants, the absence of any true land-living vertebrates, recent or extinct, on the antarctic continent placed this great land mass, half again as large as the continental United States, generally outside the calculations of most students concerned with the distributions of ancient and recent tetrapods—the four-footed amphibians, reptiles, and mammals.

Then, in December, 1967, Peter J. Barrett, a New Zealand geologist working in the Transantarctic Mountains about 400 miles from the South Pole, discovered a small fragment of a fossil lower jaw on the slopes of Graphite Peak in rocks of early Triassic age.

The specimen was too incomplete for close identification, but there could be no doubt as to its general nature: it was a portion of the lower jaw of a labyrinthodont amphibian, one of the tetrapods that lived during late Paleozoic and early Mesozoic times, from about 350 million to 200 million years ago. Here was a fossil of great significance, and it immediately drew attention from paleontologists, geologists, and biologists, as well as from the general public. Here was some slight indication that in the distant past Antarctica had been inhabited by land-living vertebrates.

Immediately, questions were raised. Was it not possible that the owner of this piece of fossil jaw had reached Antarctica by swimming across the surrounding ocean? Modern amphibians cannot tolerate salt water; if we apply the same physiological standards to the extinct amphibians, they could not have swum to Antarctica. But perhaps the oceans were less salty 200 million years ago. Moreover, some early Triassic amphibians have been found in marine sediments in Spitzbergen, although whether these fossils represent animals that habitually lived in the sea is open to question. At any rate, the evidence of one small jaw fragment, although most significant, was somewhat equivocal. More evidence was needed.

So it was that in October, 1969, a group of us (William J. Breed of the Museum of Northern Arizona, James A. Jensen of Brigham Young University, Jon S. Powell of the University of Arizona, and myself) found ourselves at McMurdo Station in Antarctica, preparing to search for fossil vertebrates. We were part of a larger group of about twenty geologists and paleontologists, working under David H. Elliot, a geologist of note and a veteran antarctic explorer.

Our expedition was a gamble, and a costly one at that. We had no assurance that we would find fossils, and our chances for success seemed to diminish every day at McMurdo, as we waited through the weeks for storms to abate. It was the stormiest antarctic spring in years. Each day, as the winds howled past our huts, driving clouds of snow across the great ice shelf and Ross Island, on which the base is located, our long-laid plans for a concerted fossil hunt became increasingly tenuous and dislocated.

At last, however, on November 22, we flew into our camp near Coalsack Bluff, a nunatak (the exposed top of an isolated mountain largely buried in ice) on the edge of an ice field some 30 miles west of the mighty Beardmore Glacier, and some 400 miles from the South Pole. Elliot had chosen this locality primarily because it was a good spot for supply planes to land. We were to have helicopter support, and we proposed, first of all, to fly across

Some of the places in Antarctica where fossils have been found are located on this map.

The Gondwanaland of 200 million years ago included the now separate continents of Antarctica, Africa, and South America, along with India, Australia, and major islands. Whole groups of land animals could have easily moved from one region to another.

the Beardmore Glacier (itself some 30 miles in width) to Graphite Peak, to begin our search where Barrett had made his discovery. We wanted to begin at a place where we knew a fossil had been found.

At this point serendipity took over. Coalsack Bluff was about five miles away across the ice, and the helicopters had not as yet arrived, so on the first day in camp some of our group went over to Coalsack Bluff because it was there. Almost immediately we found fossil bones in some low cliffs, exposed on the far side of the nunatak. Before the day was out, nearly thirty fossils had been located along a half mile or more of cliff exposures. From that day until the end of our stay, we spent most of our time excavating fossils from the sandstone cliffs of Coalsack Bluff.

Something should be said about the locale at which we were excavating the fossil bones. A frequent question asked of us on our return was: "How did you find the fossils? Did you dig down through the ice for them?"

Antarctica is commonly pictured as a great, ice-covered continent, and so it is over much of its extent. But in the Transantarctic Mountains there are extensive cliff exposures where the high mountains rise above the level of the glaciers and ice fields. The mountains in large aspect form a continuous range across the continent, but at many places there are outlying nunataks, and Coalsack Bluff is one of these. The north side of Coalsack Bluff is a long slope, largely free of snow and ice. Its lower portion is composed of dark shales with layers of coal belonging to the Permian Buckley Formation, containing, in places, abundant fossil leaves of the characteristic Gondwana plant *Glossopteris*. Above these shales and coals is the Fremouw Formation of early Triassic age, an alternation of sandstones and shales. The sandstones, generally brown or gray in color, stand up as low cliffs, and the shales form the slopes between them. There are three such sandstone cliffs, one above the other, on the slopes of Coalsack Bluff. Finally, capping the nunatak and appearing on its slopes as intrusions, are thick volcanic rocks.

The present locations of the southern continents are shown in this view from above the Southern Hemisphere. The reptile symbols indicate where *Lystrosaurus* fossils have been found.

This is the mammallike reptile *Lystrosaurus* as it might have looked in Antarctica 200 million years ago. When they were fully grown, most species reached about the size of a large present-day dog.

These dense rocks, broken and weathered into highly polished slabs, cover much of the slope of Coalsack Bluff.

The weathering processes in Antarctica are unlike those in other parts of the world. Central Antarctica is a desert, with an amazingly scanty annual increment of moisture. Temperatures are low, so there is little thawing. Much of the erosion in the Transantarctic Mountains is effected by wind, wind that sweeps off the polar plateau in fierce gales, driving the dry snow in horizontal clouds. These are the ground blizzards of Antarctica. At extremely low temperatures the snow is so hard and dry that it acts very much like wind-driven sand. The force of these blizzards polishes the hard volcanic rocks and cuts them into weird shapes. On cliffs and exposed slopes, such as the long slope of Coalsack Bluff, the winds clear the snow away, leaving the rocks exposed—a fortunate circumstance for the fossil hunter. (In another sense the antarctic winds were anything but fortunate for us; they were our worst enemy in the field, frequently making our work difficult, and at times, impossible.)

The sandstone cliffs from which we collected the bones were the solidified remains of ancient stream channels. We were dealing with sediments laid down in streams, sediments containing the bones of amphibians and reptiles that had lived in and along the edges of the streams.

It soon became evident that we were finding the bones of labyrinthodont amphibians and mammallike reptiles. On December 4, a portion of a skull was discovered that proved to belong to the reptilian genus *Lystrosaurus*. The discovery of *Lystrosaurus* with other mammallike reptiles and with labyrinthodont amphibians indicated that we had found in the Transantarctic Mountains an association of amphibians and reptiles similar to that occurring in the Lower Triassic beds of South Africa, designated the *Lystrosaurus* fauna. The *Lystrosaurus* fauna has also been found in the Lower Triassic sediments of peninsular India, and in Sinkiang and Shansi, China.

We never did go to Graphite Peak, in part because we were completely busy at Coalsack Bluff, and in part because of helicopter troubles. Nor did we go, as originally planned, to McGregor Glacier, some 150 miles southwest of Beardmore Glacier, partly because of problems of logistical support, and partly because of the delays resulting from the bad weather that had plagued us. McGregor Glacier was reserved for the following season.

The next season came, the austral summer of 1970–71, and with it the campaign at McGregor Glacier. This time the fossil hunters were led by James W. Kitching of the Bernard Price Institute of Paleontology, Witwatersrand University, Johannesburg, assisted by John Ruben of the University of California and, for a short time, by Thomas Rich of Columbia University. Again David Elliot led the entire party working at McGregor Glacier. Kitching was the best possible man to continue the search for fossils in the Transantarctic Mountains. He has spent a lifetime working in the Permian and Triassic sediments of South Africa, and it is fair to say that no other paleontologist alive can equal his experience in the search for the Permo-Triassic amphibians and reptiles that occur so abundantly in the African Karroo sequence. We knew by then that the fossil tetrapods of Antarctica are of close African relationships; Kitching was the logical man to look for additional and perhaps more complete *Lystrosaurus* fauna fossils in the Fremouw Formation.

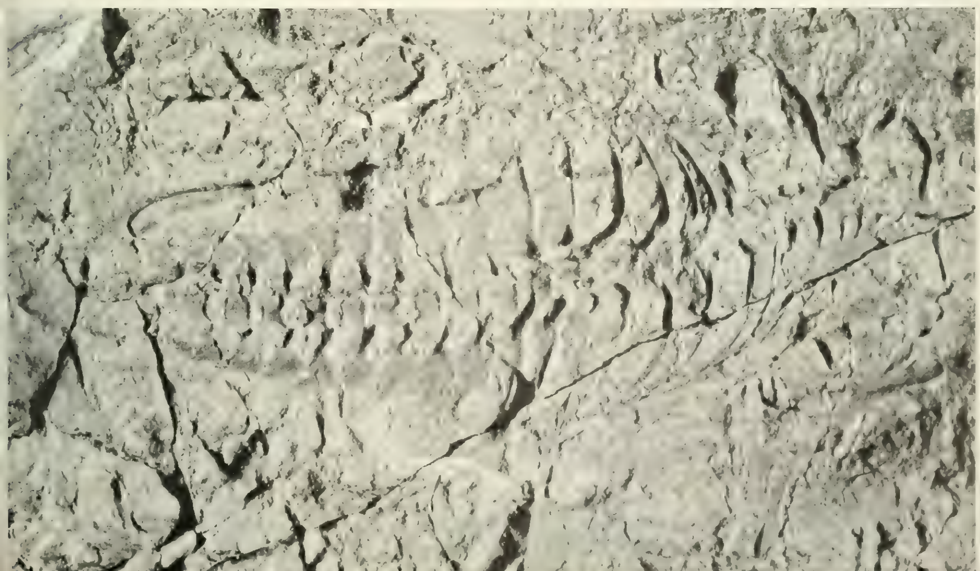
History repeated itself. On the first day in camp at McGregor Glacier, James Collinson, a geologist, discovered in the rock a skeletal imprint of *Thrinaxodon*, a mammallike reptile associated with *Lystrosaurus* in the African sediments. From then on fossils were continually found in the McGregor Glacier region, many of them articulated skeletons or partial skeletons. The fossils found at McGregor Glacier show that in addition to *Thrinaxodon*, there were in Antarctica

other mammallike reptiles similar to those found in the *Lystrosaurus* fauna of South Africa, and also such *Lystrosaurus* fauna tetrapods as the little reptile *Procolophon;* small eosuchian reptiles more or less ancestral to lizards; various thecodont reptiles especially characteristic of Triassic sediments; and labyrinthodont amphibians that may be compared not only with the African *Lystrosaurus* fauna amphibians but also with Lower Triassic amphibians found in Australia. Consequently, it is now apparent that there was a fully developed *Lystrosaurus* fauna living in Antarctica in early Triassic time, a fact of particular significance.

In the first place, the presence of a diversified *Lystrosaurus* fauna in Antarctica indicates beyond any reasonable doubt that there was a dry-land connection between the present south polar continent and southern Africa. *Lystrosaurus, Thrinaxodon,* and the other mammallike reptiles that have been found in Antarctica, as well as *Procolophon,* the thecodont and eosuchian reptiles, and the amphibians could have moved back and forth between what are now the Transantarctic Mountains and the Karroo Basin only across a land route. In the second place, the broad spectrum of the *Lystrosaurus* fauna in Antarctica is almost certainly an indication of a wide dry-land avenue, allowing the entire fauna to spread from Africa to Antarctica (or vice versa). Such a complete representation of the fauna in both areas is strong evidence against a narrow isthmian bridge connecting ancient Antarctica with ancient Africa, for we know from modern examples (from the Panamanian Isthmus, for example) that an elongated, narrow bridge acts as a zoological filter, permitting some animals to migrate along its length but excluding other animals from using it. No such filter effect is apparent in comparing the *Lystrosaurus* fauna fossils from the Transantarctic Mountains with those from South Africa. Indeed, the close resemblances between fossils in the two regions, extending down to a similarity of species among various genera, is evidence that in early Triassic time Antarctica and southern Africa were probably integral parts of a single continental land mass. The presence of the *Lystrosaurus* fauna in these two regions is probably a manifestation of a single fauna within the limits of its natural range. Again, the *Lystrosaurus* fauna, composed of various reptiles, some of them of considerable size, and of large amphibians as well, is obviously an assemblage of tropical or subtropical animals. This means that Triassic southern Africa and Antarctica probably were in latitudes lower than those they now occupy.

This brings us to the subject of Gondwanaland. The name was coined in the latter part of the nineteenth century by the Austrian geologist Eduard Suess to designate a hypothetical gigantic continent, embracing the modern continents of the Southern Hemisphere, and extending across the Equator to include the peninsular portion of India as well. This great ancient continent was considered by many geologists as useful, and perhaps necessary, to explain many similarities among the rocks and fossils

The imprint of a skeleton of *Thrinaxodon*, an ancient mammallike reptile, lies imbedded in a rock found at the confluence of McGregor and Shackleton Glaciers in the Transantarctic Mountains.



of the Southern Hemisphere continents and of peninsular India. Some of the early believers in Gondwanaland pictured it as an immense east to west land mass, including India and the Southern Hemisphere continents as they are now placed. Gondwanaland, they thought, subsequently disappeared as an entity by the foundering of large portions of land into the oceans, leaving the present continents as isolated remnants. Other students, who found it difficult to visualize the sinking of such great expanses of land beneath the ocean, thought of Gondwanaland as being composed of the present southern continents and India as we know them, all connected by long and relatively narrow land bridges. Then Wegener, and after him Du Toit, introduced a new concept, namely that the several continents making up ancient Gondwanaland were at one time contiguous, and that subsequently the ancestral land mass fragmented, its component parts drifting to their present positions. (A similar parent continent, Laurasia, has been proposed for the Northern Hemisphere, its subsequent fragmentation and the drift of the fragments having produced North America, Greenland, and most of Eurasia.)

Early opposition to the theory of continental drift included, of course, opposition to a Gondwanaland formed by the modern Southern Hemisphere continents and peninsular India. But modern geologic findings strongly support such an ancient continent, its eventual fragmentation, and the drift of its fragments to their present positions. The many facts that point to this sequence of geologic events are too complex and involved for elucidation here. Suffice it to say that the complementary theories of plate tectonics and of sea-floor spreading, which stipulate that the crust of the earth is composed of a number of gigantic plates that are constantly in motion, provide the mechanism, previously lacking, to explain continental drift.

Our present concern is how the fossil evidence accords with the concept of Gondwanaland and the theory of continental drift. Do the distributions of early land-living vertebrates, especially those that have been found in Antarctica, support Gondwanaland and drift?

As we have seen, the fully developed presence of the *Lystrosaurus* fauna in Antarctica indicates that Antarctica and southern Africa were joined along a broad front. The same is true to a somewhat lesser degree for peninsular India, where the *Lystrosaurus* fauna is found partially represented. If present-day Africa, Antarctica, and peninsular India are joined according to the similarities of their outlines at a depth of 1,000 fathoms, the "fits" between them are remarkable. This is particularly true for the edge of the African continent between Durban and Mozambique and for Antarctica along the Weddell Sea and the Princess Martha coast. Such a fit affords a broad connection between the two land masses, making of them essentially a single land.

And such a fit, together with the fit of peninsular India between Antarctica and eastern Africa, brings the localities of the *Lystrosaurus* fauna in these now widely separated continents all within about 2,000 miles, or less, of each other. This distribution suggests a very reasonable range for a terrestrial vertebrate fauna, as judged by modern standards. A single species of *Lystrosaurus* is present in Antarctica, Africa, and India; it seems quite probable that this species on the modern continents represents the disruption of what was once a relatively compact range of distribution. (The presence of elements of the *Lystrosaurus* fauna in China has as yet to be explained, but at the moment it would appear that facts are accumulating that will account very satisfactorily for the Chinese occurrences of these early Triassic tetrapods.)

So it is that the discovery of the Lower Triassic *Lystrosaurus* fauna in the Transantarctic Mountains is a paleontological development of prime importance. It helps prove the close connection of Antarctica and southern Africa in Triassic times. From this demonstration of faunal and continental relationships one proceeds to the conclusions that there was such an entity as Gondwanaland, that Gondwanaland was broken asunder, that its fragments drifted apart, and that Antarctica, once the habitat of tropical or subtropical amphibians and reptiles (and abundant plants as well), came

to occupy a position in a climate quite inimical to the life that had once flourished in benign temperatures. Other geologic and paleontological facts support the conclusions drawn from continental outlines and the occurrences of the *Lystrosaurus* fauna, such as the general expression of Permian and Triassic geology in southern Africa and Antarctica, the presence of extensive volcanic rocks in the two continents, and the development of fossil plants in these areas. But the occurrences of the *Lystrosaurus* fauna are also important; they give solid evidence for land connections. The evidence of geophysics involves certain assumptions, as does that of geology. The evidence of the fossil plants is strong, but there is always the possibility (although according to the paleobotanists, a very slim one) that these plants may have been distributed in part by windborne transportation of seeds. The evidence of the land-living tetrapods, present in the two regions as fully developed faunas, cannot be denied. These animal assemblages most surely had to move from the one region to the other on dry land.

The recognition of a *Lystrosaurus* fauna in the Transantarctic Mountains is of significance not only because it adds a large dimension to our knowledge of ancient life on what is now the South Polar continent but also, as we have seen, because of the strong confirmation it lends to continental drift and to the former existence of Gondwanaland. Important as the discoveries of the past two years are, however, they have merely scratched the surface of antarctic paleontological riches. For riches there are, in the form of numerous untouched exposures of the Fremouw Formation containing abundant fossils.

Much progress has been made in the elucidation of ancient life on Antarctica since those tragic days sixty years ago, when Scott and his companions unsuccessfully struggled back from the South Pole, dragging their sledge loaded with survival gear and with some 25 pounds of precious fossil plants. Even more progress lies ahead. In Antarctica surely are paleontological answers to many questions regarding the evolution and distribution of life on the ancient continent of Gondwanaland. □

The Mysterious Wolf of the South

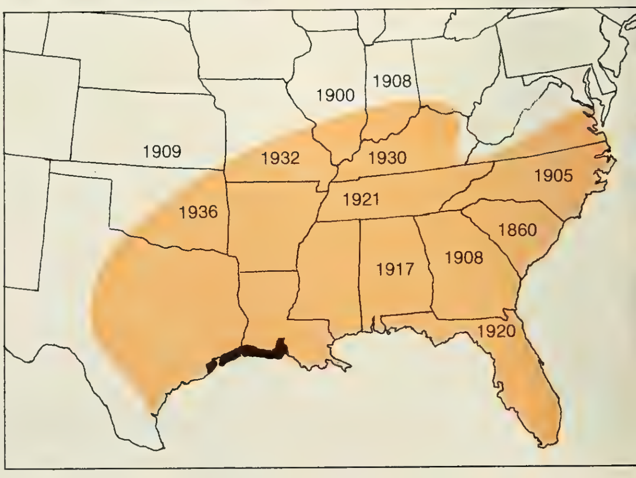
Continued from page 53

ping, poisoning, and even woods burning were widely practiced by farmers and private hunters. Furthermore, the 1920s saw the final destruction of the great forests that once covered the south–central United States. Loss of habitat, plus uncontrolled hunting, brought the numbers of many game species to an all-time low. Deprived of their natural prey, it is possible that wolves turned more to domestic stock and thus hastened their own destruction. As a final blow, the U.S. Bureau of Biological Survey began predator-control operations throughout the south–central states between 1915 and 1938. These elements combined to wipe out the northern red wolf concentration i the 1930s. But remnant populations continued to survive alon the Gulf Coast and in the large bo tomland forests, particularly i northeastern Louisiana.

Although the red wolf was dis appearing, wolflike animals contin ued to live and even increase in th south–central states. Many peopl thus believed that wolves were sti present, but careful examination o specimens showed that only a fe were as large as the true red wolf Most were hardly bigger than th western coyote, while many other seemed to be intermediate in char acters between the coyote and re wolf. After some years of observa tion it became apparent to biolo gists that these new wolflike ani mals in the south–central regio represented an invasion by the coy ote, plus the occurrence of som hybridization between individual of that species and surviving re wolves.

It seems that the clearing of th forests and the elimination of th red wolf enabled the coyote to ex pand its range eastward. Habita changes also resulted in a break down of behavioral patterns and ecological isolation, which led to the occurrence of interbreeding. Al though the extent of hybridizatio is not certain, specimens from Mis souri, Oklahoma, and most of Ar kansas indicate that few hybrid animals occurred there. Apparently a relatively pure red wolf popu lation maintained itself in these

The estimated original range of the red wolf is indicated by the light shading. Dates are the last years in which a red wolf was positively identified in each state. Darker shading indicates the probable current range; the evidence is not as strong in Louisiana as it is on the Texas coast.



areas until the 1930s when it was rapidly exterminated by man and replaced by invading coyotes.

To the south, hybridization was a more widespread and long-lasting phenomenon. Even before 1900, ranchers in the Edwards Plateau area of central Texas had noticed the existence of animals that seemed to be crosses between wolves and coyotes. A large series of skulls collected in this area from 1899 to 1918 confirms the presence of a population with characters intermediate between the red wolf and the coyote. Additional specimens show that by the 1930s and 1940s this hybrid swarm had spread over much of eastern Texas and southern Arkansas.

At that time, most of Louisiana still retained a pure red wolf population. Intensive government trapping, plus increased hunting pressure, decimated this population by the early 1950s and simultaneously came reports that the smaller coyotelike animals were moving into the state from the northwest.

Examination of hundreds of skulls collected since 1960 in eastern Texas, southern Arkansas, and Louisiana reveals that these areas are now occupied by hybrid animals. Most of these resemble the coyote in form, but are somewhat larger. As a pure species the red wolf has vanished from almost its entire natural range.

Although some biologists and trappers long ago realized that the true red wolf had all but disappeared, not until the early 1960s did government authorities become aware of the situation. As late as 1963 the U.S. Fish and Wildlife Service reported killing 2,771 "red wolves" in predator-control operations. But just the year before, Dr. Howard McCarley of Austin College had reported examining a large series of specimens and finding that nearly all of the supposed red wolves in Texas, Arkansas, and Oklahoma were being misidentified.

In 1964 and 1965, following recognition of the critical status of the species, Dr. Douglas H. Pimlott and Paul W. Joslin of the University of Toronto undertook a red wolf search. In addition to other methods, they played recordings of wolf howls, hoping to elicit responses that would reveal the presence of red wolves. Their investigation in-

dicated the survival of wolves in the Ozark National Forest of Arkansas, northeastern Louisiana and adjacent parts of Mississippi, southern Louisiana, and Chambers County in southeastern Texas.

In Louisiana, specimens have been collected and studied by the state Wildlife and Fisheries Commission and Louisiana Polytechnic Institute, but no animals definitely known to be red wolves have been killed in at least six years. It is possible that a few wolves survive in the bottomland forests along the Mississippi and Atchafalaya rivers, but even more likely that a small population now exists on the coastal marshes of southwestern Louisiana.

Continued survival of the red wolf seems most promising in the upper Gulf Coast area of Texas. Trappers and ranchers here have long reported the presence of large wolves that seem very distinct from coyotes. More than sixty skulls collected in Jefferson, Chambers, Liberty, and eastern Brazoria counties since 1963 (as part of predator-control operations) have been examined by zoologists and found to have the same size and features as skulls from the original red wolf population of the south–central United States. No skulls from this area show coyotelike or hybrid characters, but hybrid animals do exist immediately to the north and west. Although a more rigid analysis of all these specimens is planned for the near future, it is presently believed that a population of true red wolves survives in a narrow strip of coastal prairie from the Brazos River to Sabine Lake and probably on into Louisiana.

Recognition of the critical status of the red wolf led to its being placed on the rare and endangered species list of the U.S. Fish and Wildlife Service in January, 1965. Federal predator-control operations within the suspected range of the species, particularly southeastern Texas, were curtailed in 1966, and active investigation and protective efforts were begun in March, 1968. This project is currently being handled by Glynn Riley of the Bureau of Sport Fisheries and Wildlife's Division of Wildlife Services. The total area under investigation now includes Brazoria, Galveston, Harris, Liberty, Chambers, Jefferson, and Orange counties, Texas.

Riley, a little more optimistic than some earlier workers regarding the present status of the red wolf, thinks that dense populations occur in some parts of the study area. Several hundred canids are believed to be present in the seven counties, but they are not all pure red wolves. Series of specimens from Brazoria County, west of the Brazos River, and from Liberty County indicate that the hybrid swarm is pressing in from the west and north. Riley does believe that a pure population of large red wolves still exists in southern Jefferson and Chambers counties, but he has not yet extensively investigated the current situation in eastern Brazoria County. The total pure red wolf population probably does not exceed 100 individuals, making this the rarest mammal species in North America.

The future survival of pure red wolves seems dependent on maintaining the numbers and habitat of existing populations. If this is not done, there will certainly be a continued expansion of the hybrid swarm and eventual elimination of the red wolf gene pool. Riley sees a serious threat to habitat from the increasing development of the chemical industry in the area. Other problems include drainage and burning of coastal marshes, chance killing by deer and waterfowl hunters, and, especially, persecution by the cattle ranchers who own most of the land involved.

Riley's research efforts have been limited by the need to devote much of his time to gaining the cooperation of ranchers. There is a prevailing belief that the red wolf constitutes a major threat to livestock, particularly young calves. In 1968 about 100 wolves were killed by local ranchers. While it is likely that many of the cattle believed killed by wolves actually died as a result of disease, poisonous plants, malnutrition, drowning, or other factors, and were perhaps then fed on as carrion, the attitude of the ranchers must be considered.

Riley has made arrangements with a number of ranchers who agreed to permit him to handle predator control on their land. He has received encouraging cooperation from stockmen in Chambers and Jefferson counties, and the killing of wolves there has declined since 1969. Riley attempts to capture any individual animals that may be preying on livestock. Every effort is made to trap red wolves alive and unhurt, and they are then made available to zoos and research programs. In 1970, fifteen animals were taken alive and a smaller number were inadvertently killed. Remains of dead animals are saved for taxonomic studies.

Of the more than thirty animals captured in the red wolf study area since 1967, most are now in zoos. Their handling is being coordinated by the Wild Animal Propagation Trust for the purpose of maintaining a captive breeding pool that might one day be used to restore wild populations. Some of the captive specimens are being used in biochemical taxonomic research, and some are being sent to the Point Defiance Zoo in Tacoma for a genetics study.

The first full-time field investigation of the ecology and behavior of the red wolf was begun in July, 1971, by James Shaw, a student at Yale University. Radio transmitters enable researchers to determine the home range, food habits, and population structure of the species. At least thirty persons are presently conducting or planning research related to the red wolf.

Despite this widespread attention, actual protective measures have been rather slow in coming. But in 1969 the Arkansas Game and Fish Commission established a regulation to protect any red wolves left in that state. And at its 1970 session the Louisiana state legislature passed an act protecting the wolf (as well as the cougar and all birds of prey).

Probably the best way to preserve the red wolf would be through the establishment of guarded refuges within the species' range, each large enough to accommodate a viable population in its natural habitat. Some persons have suggested moving groups of red wolves to island sanctuaries off the Gulf Coast, particularly the Padre Island National Seashore. Such measures, and the final designation of any refuge, would best come after taxonomic studies have pinpointed pure red wolf populations, and field work has determined the ecological requirements of the species. Hopefully there is still enough time. ■

Vanes of the Wind *Continued from page 19*

novative, one of a kind creations of pioneer craftsmen. The favorite cock lost much of its stylized boldness and took on the characteristics of the prevalent barnyard breeds: the Wyandotte, Rhode Island Red, and Leghorn, as well as the fighting cock. Horses, too, were patterned after actual nineteenth-century racers, such as Dexter, Ethan Allen, and Black Hawk. Carrying this trend to the extreme, a wealthy Maine farmer once ordered a life-sized cow and horse for his two mammoth stock barns.

For a people as practical as the Americans, the weather vane took on a function beyond weather forecasting and decoration. It also served as a lightning rod and a trade sign. A rooster on top of a barn indicated that the farmer sold eggs. A mortar and pestle identified an apothecary; a ram, a woolen mill; a fire engine, the firehouse; a locomotive, a railroad station; and a pig on a knife, a slaughterhouse.

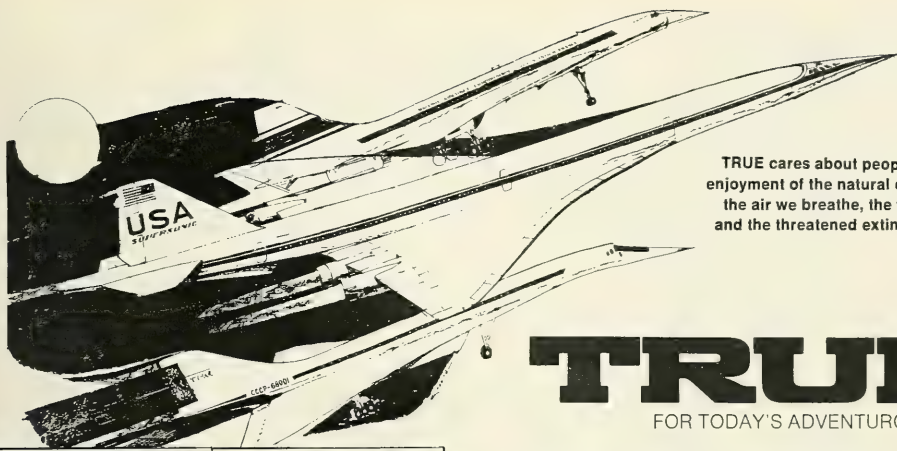
As the number and subjects grew, so too did the methods for making vanes. Although some of the most outstanding early vanes were full-bodied and three-dimensional, the vast majority of precommercial shapes were flat shapes cut from wood, wrought in iron, or hammered in sheet metal. But by the mid-nineteenth century, vanes became increasingly dimensional, and sheet copper, because of its flexibility and durability, became the preferred material.

A common method for making a vane called first for the craftsman to carve a wooden model from which he cast an iron template. The iron mold was then cut into component parts. The horse, for example, had separate molds for each side of its body, each leg, its head, and tail. Next the craftsman filled each component part with molten lead. When the lead cooled, he took sheet copper and sandwiched it between the hardened lead and the iron mold. This done, he hammered on the lead, forcing the copper to conform to the shape of the iron mold. Finally, he removed the copper and soldered the sections together, giving a full sculptural quality to the vane. Some manufacturers combined other metals with the copper, perhaps using solid zinc for a horse's head or flat sheet iron for a rooster's tail. In many cases gold leaf was applied or, failing that, paint was used as a protective covering. In time the vanes became elaborate, as craftsmen hand-chiseled, hammered, stamped, and pressed the shapes to simulate wool, feathers, fur, and scales. The full-bodied, three-dimensional designs also caught the light better than flat or low-relief designs, enhancing even the simplest vanes.

But no matter what the material or form, there was always room for individual interpretation, whether the vane was made by a professional or an amateur. And the American weather vane maker usually left some personal mark on his product. Even those vanes made on identical forms in factories showed personal variations in the way the parts were hammered and assembled. The makers, however, thought of themselves, not as artists, but as craftsmen and rarely signed their work. A notable exception was the sculptor Augustus Saint-Gaudens, whose exquisite 13-foot Diana, Goddess of the Hunt, pivoted atop the original Madison Square Garden in New York City.

While weather vanes are still made and used today, these twentieth-century versions are but weak replicas of a once great folk art tradition. They can be seen on church steeples, country homes, and barns. Worst of all, they appear as trademarks on commercial structures, such as Howard Johnson's, the newer, colonial-styled A & P's, and gasoline stations.

As a forecasting device, the weather vane has been replaced by the U.S. Weather Service and by commercial radio and television. As a trade sign, it has given way to neon. As an architectural ornament, it no longer commands attention. On the gigantic skyscrapers and impersonal apartment houses of our urban landscape, the weather vane has no home, no matter how mighty its form. It is not in the twentieth-century winds that the inheritors of Andronicus's Triton turn best, but in the museums and private art collections of the country, where the weather vane has come to be valued as sculpture created by unknown generations of American artists. ■



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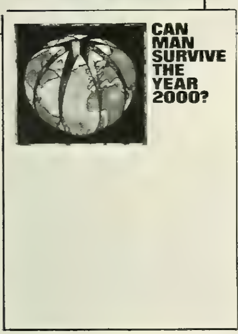

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Books in Review

B. F. Skinner's Brave New World

by Spencer Klaw

Beyond Freedom and Dignity, by B. F. Skinner. *Alfred A. Knopf, $6.95; 225 pp.*

In 1962, nine years before the publication of *Beyond Freedom and Dignity*, I was assigned by *Harper's* to write an article about B. F. Skinner. I went to Harvard to see him, and in the course of several interviews, extending over three days, he talked at length about himself and his work. For me, if not for Skinner, it was, as Skinner would say, a thoroughly reinforcing experience. To be sure, I was prepared to find him arrogant, and I was not disappointed. He seemed to have no use, for instance, for anyone who disagreed with him. He was hoping, at that time, to found a utopian community modeled on the one portrayed in his celebrated novel, *Walden Two*, and the suspicion crossed my mind that his chief motive was not to help humanity, but to prove, once and for all, that he was right about human nature, and his critics wrong.

But in the end I concluded that Skinner was no more arrogant than many admirable people who had a lot less than he to be arrogant about. Skinner is, or was, a faithful diarist, who had by then filled nearly a thousand composition books with notes and reflections, and, with his permission, I sat up most of one night looking through some of these. They revealed a man who was, God knows, impatient with fools—a category that seemed to include many of his Harvard colleagues—and who shared with Hamlet a conviction that the time was out of joint and that he was born to set it right. They also revealed the extraordinary range and fertility of his mind. All in all, he struck me as a prickly, stubborn, original, and engaging human being.

But although I admired Skinner very much, I did not much like his ideas about human behavior and its control, which he had set forth in *Walden Two* and, later, in a number of articles published in the 1950s. These ideas have now been restated in *Beyond Freedom and Dignity*, and they do not seem to me to have grown any more persuasive over the years. But they are worth coming to grips with if only because of their large and growing influence on education and on the treatment of the mentally ill. They also have the merit of forcing the reader to think hard and, perhaps, usefully about the nature of man and the meaning of freedom.

In Skinner's view, individual autonomy and freedom do not exist. In a universe governed by inexorable laws, people may like to think that they control their own behavior, but they are only fooling themselves. What a man does is completely controlled by his genetic endowment and by his environment—including, most importantly, his social environment. Specifically, human behavior is shaped by its consequences: "A child who cries until caressed begins to cry intentionally."

Much of this is neither new nor startling. The Gallup Poll has shown that some kinds of human behavior are at least as predictable as the weather, and

no one would quarrel with the idea that a baby's behavior is shaped by its mother's kisses. If our belief in our individual autonomy has been destroyed, the credit or blame belongs to Freud, not Skinner. But where Skinner differs radically from Freud is in scrapping the whole apparatus of ego, id, and superego. In his view, these concepts, like the concept of the will, only get in the way of rational efforts to understand—that is, to predict and control—human behavior. It is enough to know a man's history, the myriad ways in which his behavior has been shaped by past rewards and penalties. One can then accurately predict, at least in principle, how such a man will behave, without considering his feelings or motives or, indeed, anything he may say about what seems to be going on inside his head.

Like Freud and Marx, Skinner is bent not just on understanding man but on making him happier. If we forget about autonomy, he argues, and face the fact that man is totally controllable, we can then build a cultural environment in which the "contingencies of reinforcement"—roughly, the system of rewards—are such that men will no longer be impelled to kill, torture, or exploit one another. In the past, Skinner says, people who tried to create such environments were doomed to failure because they did not really know how to shape human behavior. Now a reliable technique is within our grasp: we need only apply to humans the methods that have worked so well in shaping the behavior of, among other creatures, those celebrated pigeons that Skinner taught to play Ping-Pong by reinforcing their random movements with grains of corn.

Even granting that what works with pigeons will work just as well with people (which many psychologists deny), there remains the problem of just what kind of behavior—and what kind of people—we want to produce. In the case of an experimental community like Walden Two one gets together a group of like-minded persons and agrees in advance on the rules of the game. In the community that Skinner was hoping to establish back in 1962, to give some trivial but perhaps revealing examples, there was to be no drinking, no extramarital sex, and no nibbling between meals. As Skinner noted in his diary at the time, "Let anyone who wants to try something else try it elsewhere."

If the whole world were Skinnerized there would, of course, be no escape. But then, Skinner argues, no one would *want* to escape, and our personal feelings about such a world are irrelevant. "The problem," he writes, "is to design a world which will be liked not by people as they now are but by those who live in it." Fair enough, perhaps, if one grants Skinner's assumptions. And yet the claim that Skinner's New Society would, more or less by definition, please Skinner's New Man is not altogether reassuring. It was Odysseus, not his companions, who objected to Circe's having turned them into swine.

Skinner's impatience with essentially political questions, such as who is to lay down the rules of the good society, gives *Beyond Freedom and Dignity* a curious air of unreality. There is nothing wrong in imagining a nonpolitical culture. But it makes no sense in the culture to which Skinner belongs—and from which the new culture must evolve—to pretend, as Skinner does, that politics do not exist. He writes, for example, that "it is no doubt a serious problem . . . that students no longer respond in traditional ways to educational environments: they drop out of school, possibly for long periods of time, they take only courses which they enjoy or which seem to have relevance to their problems, they destroy school property and attack teachers and officials." Skinner's solution is "to design contingencies under which students acquire behavior useful to them and their culture." It doesn't appear to strike him that what constitutes "useful" behavior is a political, not a pedagogical question, and that something else is wanted here besides a simple behavioral fix.

Perhaps the most serious criticism of Skinner is not that he ignores politics but that he gives no real account of consciousness and feeling. Man is only what he does: "The picture which emerges from a scientific analysis is not of a body with a person inside, but of a body which *is* a person in the sense that it displays a complex repertoire of behavior." But let us consider for a moment a particular piece of Skinner's own behavior—an entry that he made in his diary some ten years ago. It was headed "A New Year," and read, in part:

> It is nearly nine o'clock on the first day of the new year. From a deep blue sky sun streams into our livingroom. . . . My hi-fi is midway through the first act of *Tristan and Isolde*. A very pleasant environment. A man would be a fool not to enjoy

himself in it. In a moment I will go to my study . . . where I will write for two or three hours on a manuscript which I think important and which may "help mankind." So my life is not only pleasant, it is earned or deserved. Yet, yet, I am unhappy.

Skinner goes on to suggest that perhaps he is unhappy because there is so much misery in the world, and "I may feel guilty about it as my puritan heritage." He concludes:

> It is the fact that so little is being done about it! We are trapped in love of a life such as this, in false social science, in statesmanship based on historical induction . . . . Is it up to me? (A Wagnerian theme, if I ever saw one.)

On rereading this passage, it struck me that it is not enough to say, as I wrote years ago, that the main thing wrong with Skinner's utopia is that it would never produce—or tolerate—stubborn and unhappy iconoclasts like Skinner. I would now add something else. One may grant the difficulty of answering the old questions of what "mind" is, and where it is located, and how anything so immaterial as a mental state can influence events in the material world. But given the existence, never mind where, of the realm of thought and feeling that Skinner's own diaries reveal, any science of human behavior that cannot—or does not choose to—penetrate this realm seems so incomplete as to be, at best, of limited value in ordering our affairs.

Spencer Klaw is the author of The New Brahmins: Scientific Life in America. *A former editor of* Fortune, *Mr. Klaw's articles have appeared in* Harper's, Esquire, *and other magazines.*

More Reviews

SLICKROCK, by Edward Abbey and Philip Hyde. *Sierra Club Books, $27.50; 144 pp., illus.*

Perhaps I am prejudiced in favor of the country pictured, which is my native heath, but this most recent of the Sierra Club's "Exhibit Format" books

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seems to me the most beautiful of that beautiful series. Its photography, color reproduction, layout, and printing are nothing less than superlative, while its text is poetic, anecdotal, vigorous, often angry, always informed.

A basic dilemma of the Sierra Club books is here illustrated and solved. The Sierra Club is not a publishing house; it is a fighting conservation organization and outdoor club. This series has the function of defending the natural world, especially wilderness, against the forces of defacement and destruction. The author of each book had to choose between particular controversy and general philosophical statement, hard sell and soft sell, and different authors made different choices. Thus, *The Last Redwoods* is an embattled document, both text and pictures cued to a specific conservation struggle, while *Everest: The West Ridge* is the account of an ultimate testing of man in nature with no overt conservation message. *The Place No One Knew* is a requiem for a lovely, living canyon lost to the dam builders, while *In Wildness Is the Preservation of the World*, with words by Thoreau, and *Not Man Apart*, with words by Robinson Jeffers, are poetic statements of man's place in nature. *Galápagos* divides by volumes: the first celebratory, the second full of warnings.

Slickrock solves the problem by making no attempt to "marry" text and pictures. Abbey's text, often poetic, sometimes rapt and mystical, is mainly and finally polemic, full of anger at what has already happened, geared to some human mobilization that may prevent worse things. Philip Hyde's photographs are as nonpolemic as the first sun on a canyon rim.

It is all but impossible for photography to represent, much less exag-

Cathedral Valley, Capitol Reef
Southeast Utah

erate, the nobility and spaciousness of he slickrock country of southeastern Jtah. It can do beautifully by its indiidual forms. Photography (or reproducion) can easily vulgarize color, as *Ariona Highways* has been doing for ears. Hyde's recording has the integity of the rocks themselves—and the ubtlety. In spite of their grand spaces nd colossal forms, subtlety is the ultinate word for these canyons and nesas, and it is subtlety that Hyde atches superbly. (Anyone who thinks a liff of Wingate sandstone isn't subtle hould sit for just one hour and watch he light change on its face.)

Hyde is not of the school of his peer nd colleague Eliot Porter, who so disikes showing any postcard-blue sky hat he seldom gives us a sweeping iew. Hyde does, but he also shows ovingly the secret, subtle details of hading and texture—lichens on a bouller, the stained seep of a cave spring, a ucca or cactus blooming in the sand, the intricate, varnished fretwork of a conchoidally fractured cliff. I am doubly conscious of the integrity of his pictures, since I came through that country with his book in my luggage while pondering this review.

Abbey's text deals poetically with the beauty that was, and angrily with the road builders and power-plant builders who have already partially destroyed it. It is somewhat astonishing to find fury and name calling in such beautiful letterpress on such elegant coated paper, with four-color illustrations, but one has to concur in the anger and join the crusade. As Abbey says, there are already enough roads in that country. Every new one opens another gate to roadside blight, high-compression tourism, and pollution. As for the coal-fired power plants, a single one has already reduced the light in that brilliant country by 25 percent, and no filter will now filter out the particulate matter in the air. The finest pictures of the slickrock have already been taken. The superintendent of Canyonlands National Park predicts that by the time the road to Grandview Point is paved, the tourists who will then be drawn there will be unable to see the canyon. So begins to pass one of the glorious places of the earth. Unless. . . . That is the burden of Abbey's text.

WALLACE STEGNER
Stanford University

PLACE AND PEOPLE: AN ECOLOGY OF A NEW GUINEAN COMMUNITY, by William C. Clarke. *University of California Press, $9.00; 265 pp., illus.*

The study of cultural anthropology, since its inception as an academic discipline, has generally been based on empirical field research. Consequently, in anthropological monographs there has always been some recognition of the fact that particular human societies or communities occupy specific material environments and that some kind of interaction takes place between cultural and natural phenomena. Indeed, a few anthropologists have argued that the environmental setting largely determines the form of the cultural events; but in general the emphasis has been on explaining culture in cultural terms, with the physical environment being seen as a framework that merely defines the widest limits within which the cultural phenomena vary through time.

During the past fifteen to twenty

ears, however, a more sophisticated nthropological approach has emerged, ne that attempts to analyze intensively ne systemic interactions between cul- ıral and other variables. Anthropolo- ists still deal with traditional spheres of nquiry, such as kinship and social orga- ization, religion, political and eco- omic organizations, but they are now oncerned not only with the functional nd structural interconnections of the vents within and between these fields ut also with the feedback (positive and egative) that takes place between nan's thought and behavior and the vider biophysical world of which he nd his community are components. Among a number of cultural anthro- ologists today, especially in America, his holistic view of man, culture, and nvironment has led to an increasing tilization of the strategies of ecosys- emic analysis. An identifiable and rap- dly expanding school of cultural ecol- gy is developing.

One important consequence of this rend has been the growing rapproche- nent between cultural anthropologists and archeologists) and other in- estigators—human geographers, bot- nists, biologists, and nutritionists—in he prosecution of field studies and the ubsequent interpretation of the data. These multidisciplinary inquiries have ecome common, for instance, in Oceania, particularly in New Guinea, which in many ways provides an ideal aboratory situation for the systematic tudy of the adaptive features of human ulture and society.

Clarke's book stems from one such oint investigation organized by A. P. Vayda of Columbia University to study he human ecology of the New Guinea ain forest. Between 1962 and 1965 hree cultural anthropologists, a lin- guist, a nutritionist, and two ge- ographers worked with several commu- ities of Maring people living on the orthern slopes of the Bismarck Range n the Territory of New Guinea. The ublications that have so far appeared, otably *Pigs for the Ancestors*, by R. A. Rappaport (Yale University Press, 1967), demonstrate the sophis- ication and productiveness of this ven- ure, and as a result we now know a great deal more about Maring culture and society and their interrelations with he environment in which the Maring operate.

Place and People is a human geogra- pher's account of the ecology of one small, more or less localized community of Maring people. Clarke's main concern is to examine the system of land use in Maring subsistence agriculture in relation not only to such physical vari- ables as climate, topography, soil, flora and fauna but also to Maring demo- graphic and residential patterns.

Clarke concludes that "the people and their environment are close to being in a state of internal equilibrium, in the sense that the people maintain themselves in their ecosystem with vir- tually no imports of matter or potential energy and no exports or 'production' in the form of harvests of materials to be removed by man." However, he also notes that, following the expanding con- tacts of the Maring with the outside Western world, changes are occurring that may soon upset this equilibrium. The population is growing because of the introduction of medical treatment and the cessation of intergroup warfare, new and more efficient steel tools are being used, and the possibility of cash cropping is coming closer. All of this will increase the demands made by the Maring on their material resources and may well initiate a downward spiral of land degradation and impoverished diet.

Clarke writes pleasantly and con- cisely and makes his points clearly. I only wish he had presented more quan- tified statements to cover the totality of the horticultural activities of the local group he describes. Nevertheless, al- though *Place and People* deals with one small community in a remote part of New Guinea, it should interest any- one concerned with understanding the functioning of ecological systems.

M. J. MEGGITT
The City University of New York

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18-19—George Roos
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28-29—Alan Ternes
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54-65—Karl Kernberger; except map—AMNH
66—Jack Richards
68-69—David Lindroth
70—Lindroth after Margaret Colbert
71—Marc Gaede
74—AMNH
80—Julio Fernandez
88-89—Philip Hyde Courtesy of Sierra Club

Suggested Additional Reading

VANES OF THE WIND

AMERICAN FOLK ART. J. Lipman. Pantheon Books, Inc., New York, 1948.

AMERICA'S FOLK ART. R. Polley, ed. G. P. Putnam's Sons, New York, 1968.

AMERICAN HERITAGE HISTORY OF COLONIAL ANTIQUES. M. B. Davidson and American Heritage Editors. American Heritage Publishing Co., Inc., New York, 1967.

PIGEON AND MAN: A SPOTTY OLD FRIENDSHIP

ANCIENT IRAQ. G. Roux. Fernhill House, Ltd., New York, 1964.

THE ORIGINS OF AGRICULTURE. C. D. Darlington. *Natural History Magazine*, May, 1970.

PIGEONS AND DOVES OF THE WORLD. D. Goodwin. Trustees of The British Museum (Natural History), London, 1967.

THE RUMBLES ON SEISMOS

EARTHQUAKE COUNTRY. Sunset Staff and R. Iacopi, eds. Lane Magazine & Book Co., Menlo Park, 1969.

INTRODUCTION TO THE THEORY OF SEISMOLOGY. K. E. Bullen. Cambridge University Press, New York, 1963.

ELEMENTARY SEISMOLOGY. C. F. Richter. W. H. Freeman and Co., Publishers, San Francisco, 1958.

THE MYSTERIOUS WOLF OF THE SOUTH

THE WOLVES OF NORTH AMERICA. S. P. Young and E. A. Goldman. The American Wildlife Institute, Washington, D.C., 1944.

RECENT RECORDS OF RED WOLVES FROM THE GULF COAST OF TEXAS. J. L. Paradiso. *The Southwestern Naturalist*, November, 1965.

THE WOLF IN SOUTHEASTERN UNITED STATES. B. Fodor. U.S. Department of Interior Library Bibliography, No. 19, 1971.

THE GLORY OF THE LONG-DISTANCE RUNNER

THE TARAHUMARA. W. C. Bennett and R. M. Zingg. University of Chicago Press, Chicago, 1935.

TARAHUMAR OF MEXICO. C. W. Pennington. University of Utah Press, Salt Lake City, 1963.

ANTARCTIC FOSSILS AND THE RECONSTRUCTION OF GONDWANALAND

THE CONFIRMATION OF CONTINENTAL DRIFT. P. Hurley. *Scientific American*, April, 1968.

CONTINENTAL DRIFT AND A STRANGE FOSSIL REPTILE. A. W. Crompton. *Discovery*, Spring, 1970.

CONTINENTAL DRIFT AND EVOLUTION. B. Kurten. *Scientific American*, March, 1969.

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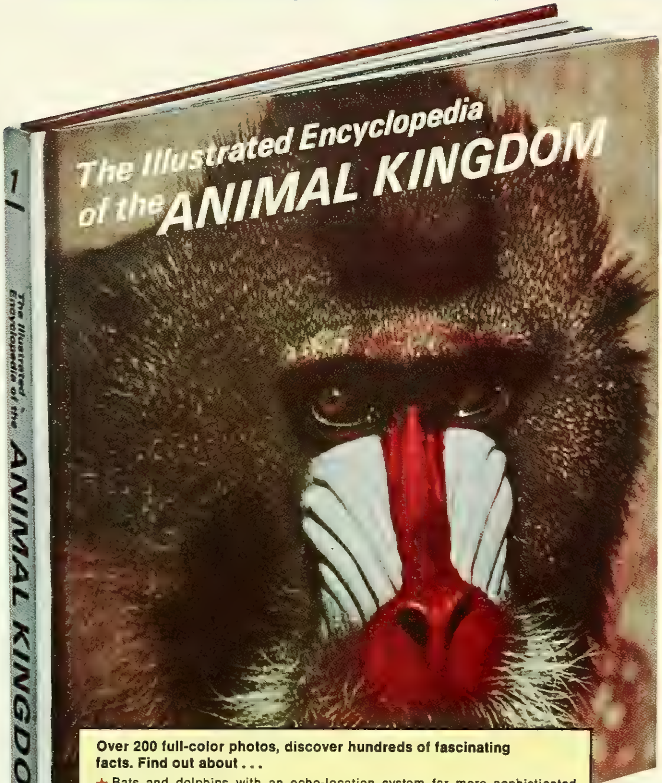

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The American Museum of Natural History

Gardner D. Stout, President Thomas D. Nicholson, Director

Vol. LXXXI. No. 2 February 1972

COVER: *On a granite kopje above the windswept plains of the Serengeti, in Tanzania, a lion surveys his domain.*

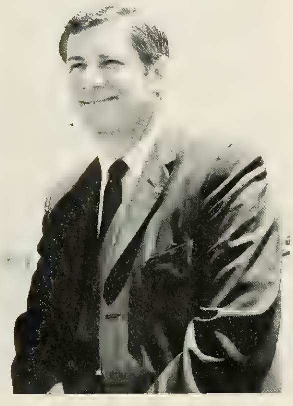
Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September. Subscriptions: $8.00 a year. In Canada and all other countries: $9.00 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices.

Authors

The inventor of a number of dental tools and techniques, **Charles I. Stoloff** has been teaching and practicing dentistry since 1916. The author of a popular book on teeth written 43 years ago, he is now at

work on his second, a survey of tooth mutilation practices around the world.

K. C. Tessendorf has been writing on historical topics since he gave up the travel business to devote full time to his avocation. He takes special pride in discovering



rare old books suitable for reprinting in limited editions; a recent find was *Hunting for Gold,* a memoir of a 49er recently brought out by American West Publishing Company. A graduate of the University of Wisconsin, Tessendorf lives in Washington, D.C.

Alain Yvon Dessaint will return to northern Thailand this year to collect costumes and to study what happens when two villages switch from growing opium to growing rice. His article on the opium trade grew out of his stay there in 1968–70, when he studied migration and settlement patterns in the Thai highlands. His earlier field work was in Mexico, Guatemala, and the Ryukyu Islands. Now a lecturer at the University of Hawaii,

Dessaint was born in France and took degrees at the University of Chicago and Stanford University.

At a time when biological studies depend increasingly on instrumentation and statistical procedures, **George B. Schaller** still believes that field glasses and unstructured field observations provide him with the best information for his wildlife studies. This excerpt from his book on the lion and other predators of the Serengeti region of Tanzania is based on three years of field work. This included several periods of continuous day and night

observations of a lion pride, which gave Schaller insights about night-hunting behavior "except when I fell asleep." He is an associate of the Institute for Research in Animal Behavior of the New York Zoological Society and Rockefeller University.

William J. Weber has been studying a colony of cattle egrets on Lake Griffin in central Florida for two years under the guidance of Lovett Williams, chief biologist of the Florida Fish and Game Commission. A graduate of Ohio State University, Weber has practiced veterinary medicine in Leesburg, Florida, since 1954. His book on

raising orphaned wild animals will be published this spring.

Part Haida himself, **William Reid** has long been involved in the culture of the West Coast Indians. As an artist he works on very large and very small scales: he has re-created a Haida house with its totems and mortuaries for the University of British Columbia, and is now creating jewelry. For seventeen

years he supported himself as an announcer for Canadian radio stations; presently he is working at his art full time in an apartment across the street from McGill University in Montreal.

Adelaide de Menil, who photographed the totem poles, was born in Paris, graduated from Sarah Lawrence College, and has since worked around the world—from Greece to New Guinea. A member

of the American Society of Magazine Photographers, she has been published in Europe and South America as well as the United States. Her photographs of Northwest Coast Indian art were made during 1966–68; some of the carvings no longer exist.

Canadian-born **Kenneth E. F. Watt** is trying to bridge the gap between advanced ecological theory and its applications. A zoologist by training, a systems analyst by necessity, he has studied ecosystems in the field, in the laboratory, and in computer models. In his essay on diversity, triggered in part by his observations of man and coral reefs, he takes a viewpoint similar to the

one he took in "The Long Arm of Biological Law," NATURAL HISTORY MAGAZINE, April, 1971. Watt's latest project involves global and regional computer system models of land use and energy flow in the human ecosystem. Watt is based at the University of California at Davis, where he is professor of zoology and research systems analyst at the Institute of Ecology.

The Fashionable Tooth

Before sparkling white became an oral fetish, gold was glamorous, black was beautiful, and a jewel or two supplied dental dazzle

Gus Johnson, left, and Dave Stallworth, star players with the Baltimore Bullets basketball team, have both had diamond stars embedded in their front teeth.

by Charles I. Stoloff

A huge gold molar suspended from the front of an office building in Union Square, New York, told Terence McGrover that he had reached his destination. He was a large, burly man, and the cut of his clothes and the angle at which he wore his pearl gray derby gave some indication of his business and position in life. McGrover was the proud and prosperous owner of one of the largest cafes on the Bowery. The year was 1901.

Ascending a staircase, McGrover found himself in a room typical of the elaborate dental parlors of the time, a room heavy with carved furniture and velvet portieres. But if Terence McGrover took any notice of the room or of the dozen waiting occupants, he gave no sign of it. He quickly made his way to the adjoining chamber and buttonholed the dentist.

"Doc, you don't know me, but I'm a person of some importance in my part of town," he said. "I want some teeth, the classiest set of teeth you can make. The price doesn't matter; just make 'em rich looking, and make 'em all gold!"

It is a pity that no picture or pattern exists of the set of teeth that that Cellini of Union Square installed in the mouth of Terence McGrover. We have only the word of his contemporaries that it was the most spectacular job to be seen in the city in those days. When the

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great Terry smiled at his customers from behind his bar, it was a sight to be pointed out to the slumming visitors from "uptown," for the dentist had taken McGrover at his word—and his pocketbook. The new teeth were 22-karat gold; and from the central incisors, two finely cut diamonds glittered, adding to the brilliance of McGrover's smile.

The esthetic appeal of gold teeth reached a zenith in this country at about the turn of the century. The lady of fashion would stand before her mirror and primp her pompadoured coiffure, smooth her tight-waisted, full-skirted gown, and note with approval the faintly golden richness that her dentist had added to her already charming smile. Her husband, no less vain, was as proud of his two or more gold teeth as he was of his custom-made, high-buttoned shoes.

Even the youth of the nation took their pennies to the candy shop to purchase brass caps, which they jammed over their teeth in imitation of their elders' dental elegance. What was a little gum soreness when one could make a swaggering entrance into the schoolyard with a sensational grin?

In the nineties and the early 1900s, gold teeth were as much a part of the fashion scene as peg-top trousers, choker collars, and chatelaine watches. There were, of course, certain practical reasons for this popularity. From the viewpoint of the average dentist, gold-shell crowns provided a simple method of securely anchoring artificial teeth; at the same time they covered ugly, broken-down, and discolored natural teeth, as well as much inferior dental work. And to the patient, gold seemed to represent the most in value received.

Gold has always been a popular, valuable, and sought-after metal, desired for its color, workability, and rarity. It was used in fine jewelry and coinage and, for almost as long, in dentistry. For some people, gold in their mouths not only created a magic and mysterious spell, it also had the added dash of elegance.

Ancient records indicate that gold was used in dental appliances more than 4,500 years ago. A simple Egyptian device made about 2500 B.C., and consisting of gold wires designed to hold a loose

Preparing for his role as a traditional geisha, a Kabuki actor stains his teeth black—a popular practice before contact with the West changed Japanese concepts of oral beauty.

tooth, was found at Gizeh, Egypt, some years ago. The Egyptian artisans of this period were very knowledgeable and clever about manipulating the metal, and were constantly called upon to create exquisite jewelry for the embellishment of their patrons.

It would seem logical that the Egyptians of antiquity, who possessed a love of color and glitter, and who went to great lengths to beautify themselves with the expert use of balms, lotions, colorful cosmetics, and sparkling jewels, would give some attention to ornamenting their teeth. The mummies of persons of high rank were decorated with gilt liberally applied to the eyebrows, nose, lips, and teeth, between which a gold coin was placed. A thin gold plate placed on the tongue completed the toilette and permitted the deceased to enter the new kingdom with a suitably gleaming façade, which might improve his chances of a cordial welcome.

Beauty aids and dental techniques were later developed by the Etruscans, Greeks, Romans, and other Mediterranean civilizations. The Etruscans further refined the art of dentistry, banding natural teeth to hold artificial ones, and sometimes covering portions of the supporting teeth with broad strips of pure gold. Basically utilitarian, the practice also became a status symbol—a luxury accessible only to persons of rank.

Archeologists have uncovered other ancient dental appliances, some dating back to the seventh century B.C., that were made to hold loose or artificial teeth for utility and improved appearance. A few were similar to Egyptian and Etruscan appliances; others, of Greek and Roman origin, were of a more advanced design. The devices consisted of gold and silver wires, and flat bands of pure gold, which were attached to the remaining natural teeth. One unusual Roman dental bridge of the first century B.C. utilized the first known gold-shell crown. It completely covered the top of the anchorage tooth, assuring a firm hold. In union with a series of additional gold ribbon loops, it held several artificial teeth, probably carved from ivory or ox bone. As far as is known, it is the prototype of all gold-shell crowns.

After such a promising beginning, a hiatus in Western dental technology set in, which lingered throughout most of the medieval period. During this time very little in the way of new or improved restorative and esthetic devices was created.

Charlatanry, such as the bizarre treatment recommended by an English doctor at Oxford in 1400, became prevalent. For those who were unhappy about the appearance of their teeth he offered two formulas: the first one to make teeth fall out, the second to make them grow again.

The first: "Dried cow's dung or the fat of a green frog would positively cause teeth to fall out when applied to them . . . . If an ox, peradventure, chewed a little frog with the grass, its teeth would fall out on the spot." The second: "The brains of a hare rubbed on the gums . . . will make teeth grow again where they have been lost."

In other areas of the world, however, developments in dental techniques and concepts of oral beauty continued to grow from earlier traditions. From Marco Polo's *Travels*, written about A.D. 1280, we learn that in China dental adornment was being pursued on a somewhat higher level. He tells of the "inter-

Professional dental care was still unavailable to many of the poor in the 1890s. When her offspring was in pain, a mother first tried to remove the decayed tooth and later worried about his appearance.

esting Chinese custom of both men and women covering their teeth with thin plates of gold, which are fitted with great nicety to the shape of the teeth and remain on them constantly."

The invasion of Mexico in 1518 by the Spanish conquistadores revealed a Maya culture in which tooth mutilation was performed on sound, decay-free teeth. This custom—notching, grooving, and filing the biting edges of the front teeth—may have been rooted in religion, but it was also practiced for ornamental purposes. At an earlier point in their history, the Maya and their subjects had developed the art of inlaying frontal teeth with gold and precious and semiprecious stones to a high level, but by the time the Spaniards arrived, this custom had faded out.

To enhance their appearance, the Yucatan Maya filed their teeth until they were sawlike in appearance. The dental operations involved are believed to have been performed by old women who used stones and water to file the teeth. As to the ability of the patients to bear the discomfort and pain of such dental work, it is possible that they were addicted to chewing coca leaves mixed with lime, and had discovered its anesthetic properties.

Other, more primitive peoples also notched, cut down, reshaped, or pointed their teeth. Knocking out, or ablating, sound teeth to deliberately create gaps in the dentition was another widespread custom in these cultures. Throughout the ages, such practices have been traditional in many civilizations for health, religious, ceremonial, and esthetic reasons. To those to whom such dental distortion was the norm, people with natural dentition were looked upon with suspicion or were often the subjects of disdain and ridicule.

The custom of knocking out sound, healthy teeth is probably Neolithic in origin. Ample evidence in fossil craniological collections indicates that it occurred during that period in Spain, England, Africa, Asia Minor, and Japan. Ablation was also practiced by people of the California coast, the Pueblo region, Florida, Alaska, and the Aleutian Islands, but much later than in other areas of the world. Studies have been made of ancient skulls to distinguish purposeful ablation from accidental or disease-induced removal. As a rule, the upper two incisors were the teeth most frequently knocked out, but other incisors, canines, and, rarely, molars were also removed in this manner.

Why ablation was practiced during the Neolithic age is obscure, but anthropological studies of more recent cultures have shed some light upon its origins and purposes. In many cultures the noncurative removal of a specific tooth was carried out as a trial of endurance and bore religious significance as a protection from death: evil spirits residing in the body could exit through the gap.

The willful removal of one or more front teeth was also motivated partly by esthetic reasons. To some people it was the highest concept of beauty to disclose a gaping hole when the lips were parted.

As recently as the nineteenth century, tooth removal was an important custom among the Kilao people living in the vicinity of Kweichow, southwest China. Girls were taken out of the house on their wedding day and two of their incisors were literally broken out. At first this act, called "damaging the husband's house," was done to identify them as married women. The custom eventually took on a connotation of beauty.

The Masai of East Africa also knocked out their teeth, but the practice has diminished greatly with the present generation. Until recently, most adult men and women had their two lower front incisors removed, considering their absence a distinctive identifying and beautifying feature. It is believed, however, that this custom had other origins. The story persists that sometime in the past a clever Masai medicine man conceived the idea of creating a gap in the lower jaw as a lifesaving device for those stricken with lockjaw, a disease to

which the Masai were highly susceptible. The gap permitted the victims to be fed.

From earliest times, filing teeth to a point was widely practiced in Africa, Southeast Asia, and Central, North, and South America. As recently as 1934 it was reported that Negrito pygmies in the Philippines sharpened and pointed their front teeth to resemble those of a carnivorous animal. The Niam-Niam tribe of the Congo region of Africa also filed their teeth, claiming it improved their efficiency in piercing an enemy's flesh during fights. They have continued the practice, now deeming it ornamental.

Perhaps the most widespread dental decoration was the deliberate coloring of teeth. Symbolic ceremony, vanity, and status were the most important factors in the use of color as dental ornamentation. Black and red were the favorite extranatural colorations. Blue, yellow, and green, were also used occasionally.

Prior to the middle of the nineteenth century, men of high rank in Sumatra flaunted their station by dyeing their upper teeth black and covering their lower ones with fine gold plate, which, in full light, afforded a fine contrast. This practice was no doubt influenced by the Chinese custom of covering their front teeth with gold plate. On other islands in that area, coloration and alteration were reversed; gold plate was used on the upper teeth and the lowers were blackened.

The skillful Lampong craftswomen of Sumatra filed the enamel from their teeth, thus roughening them to obtain better adhesion before rubbing in color.

As a beauty aid, the Bontok women of Luzon in the Philippines burned a resinous wood, then mixed the ashes with sugar cane juice to make a paste with which they blackened their teeth. Asiatic Papuans of the Nicobar Islands in the Bay of Bengal, who blackened their teeth at the age of puberty, derisively compared white teeth to those of a dog or a pig.

Among the tribes on the African continent who dyed their teeth for ornamental reasons, red was the preferred color. Regardless of how this practice originated, these people were so accustomed to the coloration that its use as a cosmetic became *de rigueur*.

In Japan the staining of teeth black, known as *ohaguro*, had esthetic importance in all social strata. Ancient Chinese records about "the black teeth people" indicate *ohaguro* was practiced some 4,000 years ago, originally only by women. In 1233 the custom was adopted by a royal family, and its use spread thereafter. Since geishas, professional entertainers who were expected to be perfect beauties, also practiced this custom, we can assume that it was regarded as beautifying. Among women it served as an indication of marriage. Many princes, nobles, and aristocrats embellished their smiles with black-stained natural teeth and Stygian artificial teeth carved of wood and ivory. The custom waned after America established commercial relations with Japan in the nineteenth century, no doubt a consequence of the Japanese desire to conform to a Western life-style.

Filing teeth or inlaying them with precious stones and minerals was a highly developed art among Central American Indians. This reconstruction features filed incisors and hematite inlays.

It was in early eighteenth-century France that dentistry became a learned profession, with its own literature and qualifying restrictions for its practice. Methods for replacing missing teeth improved gradually. The gold-shell crown (*calotte d'or*), initially used by the Romans in the first century B.C., was revived, but used in a new way. Where exposed to view, a fairly natural appearance could be achieved by enameling the bright gold with a pale tint. A similar enameling process was employed to cover shiny gold areas on bridges and full sets of teeth. Unfortunately, the enameling had no permanence. The artistic objective was worthwhile, the artisans skillful, but the process was doomed because of a lack of proper materials and technology.

The early eighteenth-century dental restorative efforts then reverted to the materials previously favored—animal ivories, hippopotamus teeth, ox bone, and occasionally gilded or painted wood carved into artificial teeth—despite the tendency of these materials to deteriorate because of mouth fluids.

The problems George Washington had with his teeth illustrate the situation well. His ivory teeth were a source of anxiety because they were uncomfortable, generated foul odors by rotting in the mouth, and had a depressing effect on his appearance due to lack of support for his sagging mouth and surrounding tissues. The result was that at times his lips had a pouting and swelled appearance; at other times they

were abnormally fallen, depending upon how successfully his latest dentures had been made.

The false teeth he began wearing after 1789—a full upper and lower set carved from hippopotamus tusks—were also not satisfactory. They were inadequate because dentists lacked the proper materials and because it was difficult to keep the teeth securely in place.

In the correspondence between Washington and his dentist, Dr. Greenwood, there were serious discussions about the discoloration caused by port wine, which turned his ivory teeth black. On December 28, 1798, in reply to a query by the President, Dr. Greenwood wrote: "If you want your teeth more yellow soak them in broth or pot liquor, but not in tea or acids. Porter is a good thing to color them."

The search continued for better-looking artificial teeth that would not rot in the mouth. A Parisian apothecary, Duchateau, hit upon a major improvement in 1774. He was continually nauseated by the accumulated malodors absorbed by his carved hippopotamus teeth, which also sponged up the unpleasant tastes from the many prescriptions he sampled. He conceived a brilliant idea to rid himself of his misery and, at the same time, to make teeth that looked more beautiful and stayed that way. Looking at the mortars in which he customarily ground his medications, he thought, "Why not use the same nonabsorbent porcelain?" This significant advance was carried to practical fruition in the 1790s by Nicholas de Chemant, a Paris-trained dentist, who made "incorruptible teeth of mineral paste" and by Fonzi, an Italian-Parisian dentist, who provided platinum hooks in the porcelain teeth for connection to the base that held them in position.

Samples of these early porcelain teeth did not reach the United States until 1817, too late to relieve Washington's discomfort. The early 1800s marked a turning point, however, as American ingenuity developed fair-looking teeth that could be made widely available. By 1844 enough improvements had been made in porcelain artificial teeth to permit their manufacture on a commercial scale.

The average citizens of most societies had, until then, only the brutal instruments of the marketplace, barnyard, and kitchen for the removal of their aching teeth, while esthetic restoration was but a dream. All previous dental treatment and replacement procedures had been the province of a select few—those of rank and well-filled purse. It was, perhaps ironically, only in the so-called primitive cultures that dental practices were widespread.

The Goodyear process of rubber vulcanization, developed in the mid-nineteenth century, further aided the availability of more attractive artificial teeth. Dental plates of moderate cost could now be manufactured, but the great mass of rubber used to cover the palate was cumbersome. The time was right for the reintroduction of an ancient dental device: the gold-shell crown. Since it could be used to hold false teeth to the remaining ones, thereby eliminating the necessity for using large amounts of rubber, the popularity of gold crowns

spurted, ushering in the American gold tooth era of which Terence McGrover and his contemporaries were such shining examples.

This popularity was short-lived however, and began to decline in the years after 1910. A new fashion in teeth began evolving in the United States: an image based on natural, wholesome, well-shaped teeth was becoming the norm.

The expansion of oral and visual communication through radio, movies, and television kept pace with technical dental improvements.

The increasingly large audiences of millions of listeners and viewers were made aware of the mouth, lips, and teeth as a basis of beauty. Words such as tempting, ravishing, alluring, and, of course, sexy impregnated the airwaves and appeared in bold type in magazines and newspapers. Their objective was to sell beauty aids—facial conditioners, lipsticks, eye makeup, tooth whiteners—by building an idealized picture of what was beautiful. Where teeth were the subject, the health aspect was only secondarily alluded to.

One could not, and cannot, escape this new image, which was appropriately called "Hollywood teeth." It sprang up on billboards along the highways, in the multicolored beauty, personality, and sex periodicals, and on movie and television screens. Closeup techniques in movies and television created new visual hazards for the stars, who were setting universal concepts of beauty. The magnification of the screen's close-ups disclosed even minute tooth defects, initiating a vast amount of dental restorative activity to eliminate them.

Plastic cosmetic caps, dubbed "Hollywood veneers," were first experimented with, but the slippage of veneers at the wrong moment, perhaps during an amorous scene or speaking passage, made more practical and permanent replacements imperative. Crowns made of porcelain and plastic came into wide cosmetic use. Carefully fitted and matched to the shades of surrounding teeth, these caps cover the entire tooth and all manner of dental defects, as well. Even close exposure does not reveal their presence. Now widely available, they have added a new dimension to the pursuit of oral charm.

With the increasing impact of global communications, even people living in the remotest areas of the world are no longer immune to the blandishments of Western culture. The allure of sparkling white teeth, carefully created by the advertising wizards of modern business, is penetrating into settlements formerly isolated from extracultural contacts. Some peoples still resist and cling to the old ways, staining and reshaping their teeth to suit their ancient concepts of what is tantalizing and captivating. But it is a losing battle; the inexorable trend is toward diminution, and eventual abandonment, of native folkways and customs. Because Western standards—based on advanced technology and material wealth and proselyted by the pervasive media—are effecting a worldwide conformity in dress, food, and shelter, pearly whites will soon become the universal concept of oral beauty. Compared to the colorful past, it will be a duller world. ■

How the Midwest Was Won

With hard labor, fire, fun, and frolic, early American settlers transformed the landscape

by K. C. Tessendorf

From the Gulf to the Great Lakes a vast, somber, and silent forest once stood, piney in the south and far north but predominantly deciduous elsewhere. Cruising along the interstate highways today, penetrating through hundreds of miles of open farmland, one may idly speculate upon who transformed that primeval forest into an agricultural plain. By the sweat of whose brow were those giant trees felled?

Two stereotypes emerge: the lone woodsman, dwarfed by the forest, chipping away persistently over decades; or the lumberman's juggernaut, slashing and raging with rapacious efficiency, feeding timber into the hungry maw of an expanding nation. Each is true in particular areas, but as a general overview one is tempted to believe that this American forest largely went up in unharnessed smoke.

A source for finding out how the forested Midwest was won are the journals of contemporary observers, among whom was William Brown, an Englishman who resided for a time among the frontiersmen. Returning to Britain, he published America: A Four Years Residence *in 1849. Brown wrote the book on America and American practices for prospective emigrants. His description of the felling of the great forest can hardly be improved upon.*

March and April is the time for the farmer who intends to clear any new land in order to secure a crop of wheat for the succeeding year. If therefore he or his family are not strong enough for the undertaking themselves, they hire out the job to persons who are accustomed to it, and are always ready at hand and easy to find. The common price of clearing land, fencing, burning up, and making ready for the seed, is

ten dollars per acre, one half cash and one half store pay or produce.

After the ten acres are marked out, the men begin the process of felling the timber, two men at one tree. They have the knack of throwing the falling tree to any point they wish, and accordingly they make it dodge against another tree in the direction they are clearing, the weight of which leaning against the next makes it easier to fell. The trees if large will average about two hundred per acre; but, if smaller, perhaps three hundred per acre; but all the trees are of one height, unless some pine trees are growing among them; these trees tower over every other tree of the forest, and never put out a single branch till they are high above the loftiest oak, beech, or maple; and some of the stems of these pines measure, before you come to a single branch, upwards of 200 feet.

Onward go the men, not heeding what sort of wood they are cutting down; they strike right and left, and at the end of a single week they will have felled the whole ten acres. Let it be understood that the felling of trees in America is not like felling them in England, where the timber is worth two shillings per square foot, and where the woodsman cuts as near the root as possible. In America they leave a stump of each tree standing about three feet high, or just the most convenient height a man can more easily use his axe with the most effect.

When the whole of the ten acres are felled, the next operation of the men is to cut off the limbs of the trees and pick out what logs will be suitable for splitting up for fencing rails and for building purposes; and if a saw mill is within a come-at-able distance, they will save some of the soft wood for that operation; or if near a city, they will save the beech, maple, and hickory which make the best firewood (and sometimes oak) for that purpose. But we will suppose that none of these advantages are within reach of this clearing: then the men only draw as much out with oxen as will serve to fence the clearing and build a shanty for either man or beast; after which they go round among the neighbours for five or six miles, and invite them to a Logging Bee.

They provide a substantial repast of beef, pork, and whiskey against the day. The females are also invited to come in the after part of the day, to take a cup of tea and join in the dance at night, and great numbers are sure to be collected together. Each man appears on the appointed day early in the morning with his yoke of oxen ready to commence business; and very soon a large heap of logs are piled up and fired; they then commence raising another pile and firing that, and so they go on till the whole five hundred years' growth of the ten acres is blazing away like—in short, like blazes!

The owner during this time is handing round refreshments to the workmen; but there is no stopping till the whole is on fire. They then turn their oxen among the grass in a neighbouring field or wood still coupled together, and betake themselves to the house where their dinner awaits them to which we may suppose they do ample justice. After they have sat awhile after dinner, and the whiskey begins to circulate freely, some will volunteer a song. At last Old Snowball, a dusky son of Africa, is called forth, and his fiddle being in readiness, each man chooses his partner and "off she goes" is the order of the day; sometimes within doors and sometimes without and sometimes both, the Negro fiddling away on the door threshold.

This amusement is carried on till daylight next morning without intermission. As soon as one party is tired they retire to chat or liquor and make room for another party. The Negro never tires; he is in his proper element and rasps away at his cracked straduarius [*sic*] as if he would saw it in two, making at the same time such contortions in face and limb as would set a whole audience in a roar of laughter. When daylight appears, then every man catches his oxen and wends his weary way towards his own clearing, and is ready and willing the next day to join another Logging Bee, or to call his neighbours to his own assistance.

The building of a farmer's first house is accomplished in the same manner: all is done in one day, and they never leave the house till the new farmer and his wife are put to bed in their new dwelling. This is called a Raising Bee and is universally followed in all the backwoods.

It answers also for making the stranger acquainted with his neighbours, and oftentimes acquaintances are formed and love matches made which continue to the end of life.

When the timber lately growing on the land is thoroughly burnt up, which generally takes a week to accomplish, if the weather be ever so favourable, the ashes are either collected and sent to the ash factory, or if that is so far distant that they will cost more carrying there than the price will amount to, which is at the rate of five cents per bushel, it is spread abroad among the stumps, levelled as well as the rake can do it, and the land is then ready for sowing. There is no ploughing or harrowing necessary; there are no weeds or grass whatever in the earth; it is quite bare of vegetation. The seed is then thrown on, there is no fear of birds stealing any of the seeds; there are none worth speaking of at all, except woodpeckers, and they live on the insects bred in decayed trees, and will not taste grain of any sort.

The men are now occupied in splitting up the logs, saved for that purpose, into rails for the fence; they use no posts, but a fence of light rails piled one upon another in zigzag line crossing over one another's ends at the obtuse angles; and a rider on the top of all. This is called a legal fence; it is about six feet high when completed, and though it looks strange and ugly to an Englishman accustomed to see a nice trimmed hedgerow, wall, or picket fence, yet it answers well for all intents and purposes of the farmer, and is surely both soon put up, and repaired afterward with very little trouble.

The stumps still stand in the ground, which cannot in general again be sown with wheat or grain till the expiration of twelve or fourteen years, when the roots become so decomposed that a yoke of oxen will draw the plough, going round the stumps and stopping instantaneously when the plough meets with any obstruction. At that time the land is found very favourable for the growth of Indian corn, among which they sow melons, squashes, pumpkins, or cucumbers. Grass seeds are sown, after the first cropping. Timothy grass and clover yield good crops without manure, except that a peck of gypsum (plaster of Paris) finely ground into powder is sprinkled upon each acre. This substance has a surprising effect upon these grasses, and you may see to a foot where it has been laid; it is a very cheap article and sells for about 1 dollar to 1¼ dollars per barrel.

I have many times, in looking over a farm, said to the owner, "Why don't you grub up the stumps, at all events from this field in front of your house?" The answer invariably was, "There are from 200 to 300 stumps per acre, and to stub them up would cost at least on the average sixty dollars per acre; and if I wanted to sell my land, the price which I could obtain for it, building included, would be at the utmost fifteen dollars per acre; so there is no encouragement for grubbing up stumps. There is also another consideration: if the stumps were grubbed up, a hole would be made in the earth where the stump and roots came out; this hole would want filling up and levelling, which would cost a great deal in labor; but if the stump is allowed to rot upon the place where it grew it will fill up its own hole, so the trouble and expense is saved by allowing them to decay where they are."

I should then ask, "How many years will it take before your land which is already in cultivation will be clear of stumps, allowing them to decay gradually?" His answer would be, "The oak, ash, and hickory will be sufficiently decayed in twenty years; the birch, elm, and whitewood in about sixteen years; but the pine and chestnut will remain sound in the earth for fifty years, and then," he would archly observe, "they turn to stone." This is as much to say that no man alive will ever see the stumps of these trees eradicated from the land (by operation of time alone) which had been cleared in his days, even if done when he was ever so young.

The locale described by Brown is almost certainly within the environs of present-day Cleveland, Ohio. Within a century and a half this ground has passed from forest, to stump-filled clearing, to farmland, to concrete and crabgrass. Such are the cumulative works of man, that the mind boggles at deciphering what changes in land use another century will bring. ■

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The Poppies Are Beautiful This Year

Raising and marketing raw opium has become big business to many hill tribes in northern Thailand, but the crop bears seeds of misery for the farmers as well as the consumers

by
Alain Y. Dessaint

To harvest opium, an Akha woman skillfully makes small incisions in the poppy capsule. By the time it reaches New York in the form of illegal heroin, $45 worth of opium from these fields will cost a dealer $2,000.

From the remote hill country of Southeast Asia and the poppy fields of Turkey, to refining laboratories in Laos, Singapore, Lebanon, and France, to Italy where, courtesy of the Mafia, it is smuggled aboard ships and planes, heroin comes to New York's streets. Once there, it moves swiftly through the city in readily available supply to meet the demand of addicts. As much as 25,000 pounds of heroin may reach the United States in a single year.

A considerable portion of the world's illegal opium comes from the small, carefully tended hillside fields of the Lisu and other tribesmen of northern Thailand. The Lisu, like their neighbors the Akha and Lahu, are typical of thousands of villagers who grow opium poppies as a major source of livelihood. They represent the first link in an intricate chain of traders, armed caravaneers, middlemen, chemists, smugglers, and pushers who operate in collusion with customs inspectors, government officials, police, and military personnel from the mountain fastnesses of inland Southeast Asia to the docks and airports of New York City. Like the middlemen and the actual consumers of opium products, the poppy growers themselves have become deeply dependent on the plant. To understand this, it is necessary to know something about the opium trade as it exists today.

Although opium is harvested in many countries, including Turkey, Mexico, India, and the Soviet Union, a significant portion of the world's supply is produced in the Golden Triangle of Burma, Laos, northern Thailand, and Yunnan Province, China. In 1969, the United Nations conservatively estimated that this area produced 1,000 tons of raw opium annually. About 80 percent of this was grown in Burma, the only country where it is still legal.

Since then, an astronomic increase in the demand for opium and its derivatives, heroin and morphine, in the United States, Europe, and Vietnam, coupled with recent limitations on opium production in Turkey, has caused a corresponding increase in its production in Southeast Asia. In response to pressure from the United States government, Turkey has begun to place restrictions on its flourishing opium industry, and is expected to outlaw it next year. The United States has agreed to give Turkey $35 million to compensate Turkish peasants who refrain from growing opium poppies, and to compensate the Turkish government for the loss of revenue from legal opium exports.

Between late 1968 and early 1970, when I lived with Lisu tribesmen, the price of raw opium at the producing village almost doubled from $24 to $45 a kilogram. Ten kilograms of opium can be refined to yield a kilogram of morphine base, which in turn is transformed into heroin with little weight loss. Between mid-1970 and early 1971, a kilogram of 96 percent pure heroin in the Golden Triangle increased in price from $1,240 to $1,780. The same kilo sells to Americans in Vietnam for about $6,000; in the United States it sells for $20,000 (up from $8,000 just four years ago). The retail price paid by a user on the street is five to ten times higher than this.

Trade routes between opium-producing villages, such as those of the Lisu, and the transshipment camps and towns of the Golden Triangle are diverse and ever changing. Caravans numbering dozens or hundreds of porters and horses, with an

equal number of guards, are used along mountain paths. River craft, fishing junks, and merchant vessels ply the Mekong. A truck driver may make more money transporting opium on one trip than he would in two years with other cargo. In Laos, most of the opium is now moved from villages by a few well-financed traders and military pilots, who use helicopters or small aircraft. Some of this raw opium is parachuted directly to drop zones in South Vietnam and the Gulf of Thailand.

The magnitude of the profits to be made in the opium trade has always attracted profit-oriented conglomerates. Britain went to war with China in the nineteenth century to force the acceptance of Indian opium. The colonial governments of Britain in Burma and of France in Indochina monopolized the opium trade. Today in Burma, the government and rival insurgent groups often squabble over who should benefit most from this trade.

High-ranking Vietnamese officials and American officers have smuggled opium or participated in reaping the profits. The Communist Vietnamese have used opium to finance their operations against both the French and the Americans. The Royal Lao Air Force has devoted much of its energy to organizing the opium industry in Laos, although production is reported down because much of the growing area is presently controlled by the Pathet Lao. Conflict between Lao villagers, for example, between the Communist-backed Meo of Faydang and the American-backed Meo of Vang Pao, has centered mainly around efforts to secure the best opium-producing lands.

Much of the insurgency among some highland minorities in northern Thailand has arisen from their fears concerning their opium lands and the future of their opium trade as they feel the pinch of tightening government controls. Troop movements throughout the Golden Triangle can often be correlated with opium harvests. For an outsider, much of the politics of the area can best be understood from the viewpoint of the opium trade.

Major entrepreneurs in the opium trade are remnants of Kuomintang forces that fled south after the armies of Mao Tse Tung gained control of Yunnan Province in 1949–50. Today these men are organized into autonomous armies, which effectively control strategic areas of eastern Burma and northern Thailand and maintain representatives in many opium-producing mountain villages. For example, the main camp of the Kuomintang 93rd Division has all the appearance of a prosperous town. Several hundred houses are scattered over the rolling hills, interrupted only by an airstrip and a well-built schoolhouse flanked by basketball courts. But in this town, today called Mae Salong, guards armed with U.S. carbines register all visitors before allowing them to enter. These guards also accompany the caravans of small, hardy mountain ponies and mules that supply remote villages with the necessities of life in return for their opium harvests. Once the opium is obtained, it is then transported to the head of the motor road where the Kuomintang maintain warehouses and stables.

Because of its effective control over this territory, the Kuomintang are usually able to levy heavy tolls on rival traders. It has been reported that when, in July, 1967, a large Shan caravan from Burma attempted to bypass the toll collectors by using a circuitous route through Laos, a thousand Kuomintang troops were dispatched to intercept it. Unfortunately for the Kuomintang, however, the battle reportedly attracted the attention of the local Lao military commander, who ordered T-28 planes to strafe both sides. More than 300 Chinese and Shan were killed, and the Lao general collected his own toll of some $35,000.

The initial refining of raw opium is a simple boiling process, which can be done either in the producing village or at the transshipment point. Further processing into morphine and heroin takes place only in a few dozen refineries because it requires exact instruments, supplies of acetic anhydride, and specialists with some knowledge of chemistry. In the past, these refineries were located in such places as Hong Kong, Singapore, Saigon, and various cities in Europe, but in the last few years some have been built nearer to the areas of production, especially near Mae Sai on the Thai-Burma border and along the Mekong River near Ban Houei Sai, Luang Prabang, and Vientiane in Laos. From such towns and refineries in the Golden Triangle, opium, morphine, and heroin are smuggled by every conceivable means to Bangkok, Phnompenh, Saigon, Singapore, Hong Kong, and on to distant markets in the United States, Canada, and Latin America.

These refineries have become so

This innocent-looking flower is the source of the drug that, in one way or another, so drastically affects the lives of many people.

For a bountiful harvest that will make him rich, a Lisu man, above, prays to the local spirits who have allowed him to use the land. Lisu women, above right, make many passes through a field to gather opium from the capsules. Poppy seeds carefully collected and stored, insure an Akha farmer's next crop, far right.

expert that they now produce heroin rated 96 to 97 percent pure. This remarkable technical achievement was motivated by the American market in Vietnam, smaller but more lucrative than the poorer market of Chinese opium smokers. In past years, much of the opium was consumed by Chinese (there are still more than 100,000 addicts in Hong Kong alone), but with increasing government controls, many have switched to heroin, which is easier to transport and conceal since it is more concentrated and less aromatic.

Everywhere, opium seriously—and too often destructively—affects the lives of those involved with its use as a drug. For the person who requires it for the escape it offers from a life of misery, death frequently becomes the only real escape. Middlemen are lured by the attractive profits to be made dealing in opium or heroin, and are thus drawn into a business that is risky both because the drug is illegal nearly everywhere and because of the threat of rival entrepreneurs.

For the villagers who grow and market raw opium, such as the Lisu of northern Thailand, dependence on opium production creates foreboding and uncertain prospects for their future. In recent years, some Lisu have managed to attain a surprisingly high standard of living by cultivating poppies. Modern material goods, medicines, and other conveniences are within the economic grasp of more and more mountain folk, even in the remotest villages. But opium production has enmeshed them in an external money economy dominated by forces they do not understand, and serious demands placed on traditional agricultural practices threaten to undermine the economic well-being of the Lisu.

Lisu tribesmen were not always prosperous opium farmers. When they moved south from the Shan states of Burma in the early years of this century, they were denied access to the rich, rice-producing valleys of northern Thailand by the more numerous and politically powerful Yuan, Shan, Lue, and Chinese already in the area. The thin soils and steep slopes of the marginal highlands, where the Lisu were forced to settle, made it impossible to raise sufficient rice and other food crops. Acutely aware of being

a people without a country, the 11,000 or so Lisu who lived interspersed among other highlanders turned instead to the lucrative business of raising opium.

At Evil Peaks, the Lisu village in which I lived for a year and a half, an analysis of labor input and crop yields revealed that labor expended in opium production was almost twice as rewarding as that expended in cultivating rice, a fact the Lisu recognized long ago. Only a small percentage of the households at Evil Peaks were self-sufficient in rice, while nearly all households depended on opium for the bulk of their income. After the opium was sold, rice, clothing, and other necessities were bought from the valley-dwelling Yuan or Shan.

To know the Lisu, one must understand their shifting agriculture. The basic Lisu economic unit is the household, consisting of a husband and wife, unmarried children, and perhaps a relative or two. Normally, the youngest married son and his family also remain in the household, continuing it into the next generation. Each household works its own fields, usually one rice field and two or more opium fields, in which maize and vegetables may also be planted. Fields are selected each year early in the dry season (December or January), and any person may choose any plot of unused land he wishes. There is no block of village fields.

Lisu fields and those of neighboring Lahu, Akha, and Karen are often side by side, and sometimes fields are given or sold across ethnic boundaries, although such transactions are not registered and have no sanction under Thai law. Once a Lisu has chosen and cleared a field, he has traditional, exclusive rights of ownership for as long as he lives in the same village, even if the field is fallow. Any dispute arising over land or boundaries is settled by mutual agreement or by the village headman. The disputes are discussed over many cups of rice and

maize liquor, which lubricates the conversation and stupefies the quarrelsome. The headman must attempt to reach a settlement acceptable to all involved, otherwise the offended may resort to violence or emigrate from the village.

The Lisu farmer is highly rational in choosing a field. He considers such factors as soil color and texture, the presence of specific plants and bamboos associated with potentially good fields, the absence of pests—rats, monkeys, and Himalayan bears—as well as human thieves and spirits who cause accidents or poor harvests. The Lisu utilize land only temporarily, with the permission of local spirits to whom they address prayers during each phase of cultivation.

Opium fields are generally clustered near the highest mountain ridges; at this latitude, opium poppies grow best at altitudes above 3,000 feet. Rice fields are cleared at lower elevations, often along mountain streams. After the land is cleared, the cut vegetation is allowed to dry, and at the beginning of the wet season (April or May), the fields are fired. Shortly after, rice is planted on low fields, maize on high fields. During the rainy season, the fields are weeded, and the maize fields hoed in preparation for the planting of opium, which takes place just before the rains stop (September and October). Poppy seeds are scattered and the soil hoed over; the still-standing maize protects the young plants. Shortly afterward, rice is reaped and threshed. This is a busy time, and it is not unusual for Lisu to set out for their fields at three or four o'clock in the morning.

Opium fields must be thoroughly and constantly weeded and thinned, either by hand or with short-handled hoes. Many households stagger the times of opium planting to spread out the labor requirements and to insure that the whole crop will not be ruined by short-term variations in rain and sunlight. The long days in the opium fields are also spent cultivating vegetables: mustard greens, cucumbers, and squashes (whose leaves are eaten), cabbages, beans, dwarf tomatoes, potatoes, taro, yams, garlics, onions, and chili peppers. Young poppy leaves are also eaten.

Opium is ready to tap in December, and tapping continues through January and February. Entire mountainsides are covered with white and purple poppies swaying with the wind, and the Lisu comment enthusiastically on the beauty of the fields, the promise of a good harvest. A few days after the petals of a poppy fall, the capsule (a greenish, squashed sphere) is exposed. These capsules are examined daily to determine the best time to begin tapping. Scored too early, the milky resin is too thin and runs to the ground; scored too late, the opium loses strength. Scoring the opium poppy is the most exacting of any Lisu agricultural task, and the Lisu claim that only they and the Meo and Yao are adept at it.

Using small, curved blades, an incision is carefully made in the capsule. If the incision is too deep, the resin will run out on the ground, but if it is too shallow, it will harden in the capsule. Both mishaps ruin the capsule. Scoring must take place under a bright sun so that the resin exudes and congeals. On the following day, the juice, which has hardened and turned a yellowish brown, is collected with a curved scraper made of bamboo or old kerosine tins. Spitting on his fingers, the collector moves the sticky opium to the back of the blade. When the broad blade is piled high, the opium is wrapped

Continued on page 92

Addiction is not a serious problem for most highland people, and those who smoke opium are often, like this Akha, older men. Such a scene is more common in Hong Kong or Singapore where, to Chinese addicts, opium is the most important thing in life.

Predators of the Serengeti: Part 1

The Social Carnivore

Lions have evolved complex group behavior to survive on the shifting numbers of large and small prey in their habitat

by George B. Schaller

Predation greatly influences the dynamics of animal populations, yet there have been surprisingly few documented studies on the impact of large carnivores on populations of hoofed animals. The large predators have either been exalted for their beauty or damned for the harm they supposedly do to those wild animals in which man has a vested interest.

To observe a lion rush from concealment and, in a flurry of violence, bring down a zebra, or to watch a pack of wild dogs pursue and catch a gazelle, is loathsome to some observers but beautiful to others, who admire the precision of these actions, the unrestrained yet dispassionate vitality of the moment. Predation, however, must be judged, not by emotional reactions toward individuals, but on the basis of its effect on populations.

In 1966 John Owen, director of the Tanzania National Parks, in-

After a tension-filled stalk, a lioness charges a herd of zebra on the Serengeti Plains. If the fleet zebras have more than a few seconds to escape, she has almost no chance of catching one.

With a lunge at a zebra's neck, a lioness pulls it down. Death by strangulation often follows. The zebra is one of the most important food sources for Serengeti lions.

The lioness' flattened ears and lowered head are a strong warning against intruders. Single lions, especially, must guard their kill vigorously against hyenas.

vited me to join the Serengeti Research Institute to make a three-year study of lions in the Serengeti National Park, especially to answer the question, "What effect does lion predation have on prey populations?" The park administration was interested in maintaining the lion, the major predator in the park, while preserving the region's million or so hoofed animals, probably the largest such concentration in the world.

To determine the effects of lion predation was a complex endeavor for, among other problems, five species of large predators preyed on some twenty species of hoofed animals in the Serengeti region. This is in contrast to North American predation studies, which deal with only one carnivore subsisting mainly on one or two kinds of prey.

The Serengeti, with its flat-topped acacias and huge herds of animals, is the quintessence of Africa, a region of light and space that makes research there an esthetically rewarding experience. The predators add tension to this scene, enhancing its vitality with their aura of impending violence. There is the lion: indolent, "radiating a kind of lazy, lordly power born of the carelessness of authority," as Maitland Edey phrased it. In contrast, the leopard seems a furtive creature of the moon, and the cheetah an elegant aristocrat. In recent years the spotted hyena has metamorphosed in the public eye from a mobile garbage bin into a powerful and skilled hunter, gaining a measure of respect in spite of its "botched and skulking form." There, too, is the wild dog, whose mere existence arouses abhorrence and intemperance even in such a conservationist as Carl Akeley, who said after shooting down a whole pack, "That's the first shooting on this whole trip that I've enjoyed."

These predators, each so different in the superficial impression they convey, differ also in their habits, thereby raising the innumerable biological questions without which even the most interesting research would become routine. As I began to recognize many of the animals individually, the study moved from an abstract plane—with an emphasis on collecting quantitative data—to a more emotional and, hence, more satisfying one. Knowing the history of many animals, I empathized with their problems. I anticipated their future. Male No. 134, for example, is to me not merely a nomadic lion, which gained and lost a territory, but a living entity, a part of the vastness of the plains and the kopjes, the small hills, that jut from them. He represents memories of the immense silence of night when even his footsteps were noisy interruptions; of the heat waves at noon transforming distant granite boulders into visions of castles, and zebra into lean Giacometti sculptures.

The Serengeti region is a vast, austere area of plains and hills in northern Tanzania. Stretching westward for some 100 miles from the Crater Highlands and the Rift Valley are the Serengeti Plains, covering some 3,200 square miles. When verdant and covered from horizon to horizon with herds of wildebeest, zebra, and gazelle, the plains surely present one of the loveliest sights on earth.

At their western boundary, hills rise abruptly to a height of 1,000 feet above the level of the Duma and Mbalageti rivers. To the north are other hill ranges, which run east and west down the Corridor, as this area of the park is called. These hills are dry and barren after the grass has burned each year. The northern part of the park, called the Northern Extension, is gently rolling and cut by numerous streams. Confined to a narrow strip along both banks of most streams is riverine forest. The canopy ranges from 30 to 80 feet in height and is often dense with numerous trees, saplings, shrubs, creepers, and forbs growing in profusion to ground level. Fires burn through most of the woodlands during the dry season, leaving the terrain open with little cover behind which predators can stalk their prey. The dense vegetation along the rivers persists, however, and this the cats use when approaching animals that have descended to the stream bed to drink.

The average year is divided into a dry season, from June to October, followed by a period of rain in November and December. January and February tend to be dry with only occasional showers. About one-third to nearly one-half of the total annual precipitation falls from March to May. The seasons vary considerably each year from this average pattern, primarily as a result of the erratic and unreliable appearance of the rains.

During the height of the dry season, the plains present a bleak appearance. The long grasslands have been burned, leaving the ground black and bare except for occasional scorched tufts. The dry stubble crackles underfoot. Wind whips over the rises, and sandy-colored dust devils spin along. Now and then an ostrich appears, vibrating in the heat haze on the gray horizon. The woodlands dry up progressively. Fires, set by man, both inside and outside the park, burn over three-fourths of the woodlands between June and October, eliminating the dry grass, killing saplings, and leaving dead trees as ashy skeletons on the ground. The migrating prey move ceaselessly, first west, then north, feeding on the dry grasses that remain or concentrating in an area where a local shower has stimulated a flush of green.

Towering thunderclouds balanced on black columns of rain herald the onset of the wet season in late October or November. With heavy rains in late November and December, the woodlands and plains are suddenly transformed from the predominating colors of black and gray to an intense green as the grasses and the leaves of trees sprout anew. The migratory species flood back onto the plains. With the variable weather from January to May, the plains may be either wet or dry. The herds eddy back and forth, retreating westward and southward into the woodland during a dry spell, only to surge out into the open once more with renewed rain. This pattern continues until the onset of the dry season. These movements of prey profoundly influence the behavior of the lion and other predators of the Serengeti.

Exceeded in length and weight

only by the tiger, the lion is the second largest feline predator in the world. Within historic times it was distributed from Greece throughout the Near East to India and over much of Africa except in the driest deserts and in the rain forests.

The lions of central Europe—whose profile man scratched into the cave walls in France more than 15,000 years ago—died out before historic times. They survived in Palestine until the Crusades and well into this century in Syria, Iraq, and Iran. The only known population of the Asiatic lion occurs now in the Gir Sanctuary of Gujurat State in India, where about 175 animals represent the remnants of a population that 150 years ago was widely spread over the northern half of the country.

In Africa, however, lions continued to survive in the vast woodlands and plains. Of the ten recognized subspecies of African lion, only two, the Berber lion of North Africa and the Cape lion of South Africa have become extinct. In recent years agriculturists have eliminated much lion habitat, and pastoralists with their livestock are coming into increasing conflict with the cats, but huge tracts of land both inside and outside of reserves still harbor them. Particularly in Kenya and Tanzania, the lion leads a natural life, roaming at will and preying largely on the local fauna.

Konrad Lorenz has written, "There are certain things in Nature in which beauty and utility, artistic and technical perfection, combine in some incomprehensible way, the web of a spider, the wing of a dragon-fly, the superbly streamlined body of the porpoise, and the movements of a cat." And at no time is such movement more vitally beautiful than when a lion tautly snakes toward prey. I found the fleeting hesitation between the end of a stalk and the final explosive rush a moment of almost unbearable tension, a drama in which it was impossible not to participate emotionally, knowing that the death of a being hung in the balance.

The success or failure of a hunt depends as much on the response of the prey to the lion as on the behavior of the cat itself. While a lion is well endowed with claws and teeth to grasp and kill prey, it lacks speed. This fact is clearly recognized by the various hoofed animals. In most instances lions can capture an animal only if they can approach it so closely that it has no time to attain full running speed before being grabbed.

As long as lions are visible to them, prey behave in a remarkably casual manner. Resting lions are usually ignored, and a typical sight on the plains is some lions encircled by grazing wildebeest and zebra slightly more than 100 yards away.

Because of the prey's fleetness and keen senses, lions must seek every possible advantage to catch an animal. Lions hunt mainly at night, unquestionably because they are able to stalk with greater chance of success under the cover of darkness. Lions appear to be aware of the advantage that darkness gives them. They frequently watch prey in late afternoon only to wait until dusk before hunting.

The height and density of vegetation influence the ease with which lions can stalk without being detected. About three-quarters of the animals taken on the open plains were near some low cover when caught. About one-third of the kills in the woodlands were made near a river where the dense vegetation and broken terrain enable lions to stalk undetected.

Buffalo, particularly solitary bull buffalo, concentrate their activity along river courses and therefore are often killed there. Other species also favor riverine habitat or concentrate there during the dry season. Thus, these narrow strips of shrubs and trees provide lions with prey out of all proportion to the land area they cover.

Lions are catholic in their tastes, and the prey they kill ranges from crocodiles, guinea fowl, hares, and baboons to various antelopes, buffalo, and on occasion, other lions. Between 1966 and 1969, the Serengeti lions were known to have eaten eighteen kinds of mammals and four kinds of birds. Prior to my study, they once killed and ate a yearling rhinoceros, a porcupine, and a leopard cub, but they prey mainly on wildebeest, zebra, buffalo, and topi.

The size of prey conspicuously influences the food habits of lions. An adult elephant weighs 7,500 pounds and more, a hippopotamus at least 4,000 pounds, and giraffe and rhinoceros usually more than 2,000 pounds. These species are so large—and adults may defend their young so vigorously—that lions rarely prey on them, except for small numbers of giraffe. Prey that weighs more than 2,000 pounds is relatively safe from lions and, in fact, has almost escaped the influence of predation in general.

At the other extreme, small mammals and birds are not hunted much, undoubtedly because the energy output in trying to subsist on, for example, hares or dik-dik is not commensurate with the input. Lions do capture gazelle fawns weighing a few pounds, but only incidentally. In the absence of other prey, lion prides around Seronera, the Serengeti Park headquarters, may subsist for long periods on Thomson's gazelles weighing 30 to 50 pounds. The usual prey size thus ranges from about 30 to 2,000 pounds.

It was once thought that lions follow the moving prey, but actually only a small nomadic segment of the lion population follows the migratory herds. Most wildebeest, zebra, and Thomson's gazelle—about 62 percent of the prey biomass—are migratory and unavailable to most lions for part of the year. Since movements of prey are largely influenced by erratic weather, availability of the migratory herds is usually a matter of chance.

In addition to killing their own prey, lions readily scavenge from other predators and eat animals that have died from disease and other causes. This accounts for about one-fifth of their food items. The effect of vultures on the food habits of lions needs special comment. With many birds gorging on a zebra or wildebeest, little meat may be left for a predator after an hour. Much of a vulture's food consists of animals that have died of disease or malnutrition. If there were no vultures, such carcasses could provide

Food items (killed and scavenged) eaten by lions in various parts of the Serengeti Park (percentages are in parentheses).

	Plains	Masai and Seronera	Edge of Woodlands	Corridor	Northern Extension
Wildebeest	159 (56.7)	121 (22.0)	97 (37.3)	22 (32.8)	10 (47.6)
Zebra	81 (28.9)	87 (15.8)	63 (24.2)	21 (31.3)	3 (14.3)
Thomson's g.	21 (7.5)	276 (50.0)	31 (11.9)	3 (4.5)	
Buffalo		13 (2.4)	40 (15.4)	5 (7.5)	7 (33.3)
Topi	4 (1.4)	18 (3.2)	7 (2.7)	4 (6.0)	1 (4.8)
Warthog		12 (2.2)	5 (1.9)	4 (6.0)	
Eland	9 (3.2)		3 (1.2)	1 (1.4)	
Grant's g.	3 (1.1)	7 (1.3)	1 (.4)		
Hartebeest	1 (.4)	1 (.2)	4 (1.5)		
Giraffe		3 (.5)	1 (.4)	5 (7.5)	
Impala		1 (.2)	1 (.4)	2 (3.0)	
Reedbuck		6 (1.1)	1 (.4)		
Bushbuck			1 (.4)		
Waterbuck			1 (.4)		
Pangolin			1 (.4)		
Hare		1 (.2)			
Lion	1 (.4)	2 (.3)			
Hyena	1 (.4)	1 (.2)			
Ostrich			3 (1.1)		
Guinea fowl		1 (.2)			
Sand grouse		1 (.2)			
Saddle-bill stork		1 (.2)			
Total	280	552	260	67	21

lions with an appreciable amount of meat.

In the daytime, any kill in the open is kept under constant surveillance by vultures. A few birds may wait nearby, but often none are in sight until lions leave the vicinity of a carcass. When the lions have left, white-backed and Ruppell's vultures plummet from the sky, the movement and possibly the noise alerting vultures for many miles in all directions, with the result that a few minutes later the remains are covered with a writhing, hissing mass of birds. Lions may be deprived of a second meal from a kill if for some reason they fail to guard it closely.

Lions, like hyenas and wild dogs, are vulture-watchers. If several birds fly past and land nearby or if they descend suddenly from the sky, a lion may trot over and investigate the site. One male, for example, hurried toward several vultures a half-mile away only to find, after much sniffing and searching, the solitary rib of a gazelle. At other times, vultures have finished the meat or a hyena has snatched, and departed with, the remains. Often, however, a meal is to be had. In this respect vultures benefit lions, but I would estimate that, on the whole, lions lose more food from vultures than they gain.

Zebra make up about 25 percent of the total migratory wildebeest and zebra population, yet 38 percent of the kills of these two species on the plains consisted of zebra, and at Seronera and in the woodlands the figures were 42 percent. The zebra's importance to the lion becomes even more apparent when multiple killings are considered, those in which lions capture more than one animal during a cooperative rush. Thirty-four percent of the wildebeest kills were multiple ones. Of the zebra killings, only 10 percent were multiples. If food items are tallied on the basis of the number of successful hunts rather than the number of animals killed, wildebeest and zebra would contribute almost equally. The greater proportion of zebra over wildebeest in the kill sample is largely due to the greater availability of the zebra throughout the Serengeti at all times of the year, which makes it the most important prey animal for the lion, although it only ranks third in number available.

If the various species are rated on an annual basis in terms of pounds of food they provide to lions throughout the Serengeti, my guess would be as follows: zebra, 30 percent; wildebeest, 20–25; buffalo, 15; Thomson's gazelle, 2.5; and other species, 27.5–32.5. The figure for gazelle may seem low, but lions prefer large prey, killing gazelle either incidentally or, around Seronera, out of necessity for a brief period each year.

Lionesses hunt proportionately more often than do males. In 71 hunts by single lions that were in groups of mixed sex, males took the initiative only twice. Out of a total of 1,210 lions observed stalking and running, only 3 percent were males and none participated in driving or ambushing. Males, however, respond quickly to an unexpected opportunity. Nomadic males must of necessity kill more for themselves. Here are some examples of various hunting methods I have observed.

Unexpected hunting: A lioness was walking along a river when two Thomson's gazelle rushed up the embankment in front of her. She lunged, and sliding sideways hooked a gazelle in midair with two claws. It crashed on its side and she grabbed it with both paws while simultaneously biting it in the nape. A zebra foal slept so deeply that it failed to hear its family move away and awakened only briefly after a male lion pounced on it.

Ambushing: At 8:35 A.M., a lioness sits in a small patch of grass by a river watching several gazelle at a distance of fifty yards. At 5:50 P.M. she is still there, crouching as five gazelle approach cautiously, alternately walking and stopping. A male gazelle descends the embankment, closely followed by a female. The lioness raises herself slowly, only her head above the grass, and when the female gazelle passes at five yards, the lioness rushes. The gazelle leaps forward and the lioness misses, but using her momentum swerves and bowls over the male. She hauls him up the em-

bankment where he ceases to kick.

Driving: About 20 gazelle moved into a cul-de-sac between the junction of two creeks. Two lionesses seventy yards away walked toward them slowly without attempting to conceal themselves. The gazelle first retreated, but then instead of crossing one of the creeks, most of the gazelle raced back toward the lions. One lioness rushed, missed, pursued another gazelle, and failed again. But two male gazelle tarried and a lioness chased one of them sixty yards while he seemed undecided about an escape route. Finally he entered a reedbed where he was caught.

Digging: One night at 12:35 A.M., the Masai pride was moving across the plains when a lioness stopped and began to dig at the entrance of a burrow. Two lionesses joined her. One lioness dug vigorously until at 1:35 A.M., some three yards of tunnel were exposed. She looked in the hole, jerked back, ducked in again, and grabbed something. Her body grew taut with the strain of pulling. She retained her hold for eight minutes until she was finally able to pull out a screaming adult female warthog by the nape.

Grabbing prey in water: On two occasions a lioness plucked a swimming gazelle from a river.

Running by single lions: Four lionesses and five cubs were walking in single file along a road. One saw some fifty gazelles, about 150 yards away on a sloping riverbank leading to a waterhole. She ran toward them. Most of the gazelles fled, but a few remained by the water, unable to see the lioness until she rushed over the crest of the embankment and captured a male.

Stalking by single lions: Perhaps the most striking aspect of a stalking lioness' behavior is the care with which she watches prey. She advances when it lowers its head to graze or stands facing away from her. If an animal suddenly becomes alert, she halts, sometimes standing motionless with paw raised in midstride. She is fully aware of the advantage that cover confers, and when prey moves behind some shrubs or out of sight into a ravine, she may run closer. For example: A lioness sees eight kongoni some 500 yards away, and she lies and watches them. When they move to a waterhole partly hidden by tufts of grass and acacia saplings, the lioness immediately trots closer in a semicrouch and from a distance of forty yards rushes at full speed. The kongoni scatter. She follows one and swipes with a forepaw but misses. All escape, only to halt sixty yards away and watch her sitting by the river.

Communal hunting: When several lions spot potential quarry they characteristically fan out and approach on a broad front, sometimes spread over 200 yards of terrain. By spreading out widely, lions increase their chances of coming into contact with prey, as shown in this example: At 6:45 P.M., five lionesses and a male see a herd of some sixty wildebeest more than a mile away, just black dots moving against the yellow-gray plains. The lions walk slowly toward them. At dusk the wildebeest bunch up. The last light has faded at 7:30 when the lions stop 300 yards from the herd. The lionesses fan out and advance at a walk in a front 170 yards wide, the male 65 yards behind them. When they are 200 yards from the herd, they crouch, and I can see only an occasional head as they stalk closer; the male remains standing. Five minutes later, a female on the left flank rushes and catches a wildebeest. The herd bolts to the right and two lionesses and the male run at an angle pursuing the wildebeest about 100 yards without success.

Cooperation, while clearly evident, is relatively simple in nature. On 29 occasions during my study, one or more lionesses encircled the prey, sometimes by detouring far to one side. The other lions waited during the flanking movement as if in anticipation of prey fleeing in their direction.

The success rate is determined by the hunting method. Unexpected hunts are highly productive (61 percent success), as are such minor ways of obtaining food as digging for warthog. Stalking by single lions, driving, and ambushing are equally successful (17–19 percent), but running by single lions shows a low return (8 percent). When two or more lions hunt together, their success is 30 percent, an important figure not only because it is sizable but also because this method of hunting is responsible for nearly half of all attempts. Large lion groups do not catch prey more successfully than small ones, but there is an increase in the actual number of animals captured.

Although solitary lions may on occasion successfully attack adult giraffe and buffalo, these species are usually hunted cooperatively. I saw lions stalk or chase giraffe on ten occasions, none of them successful.

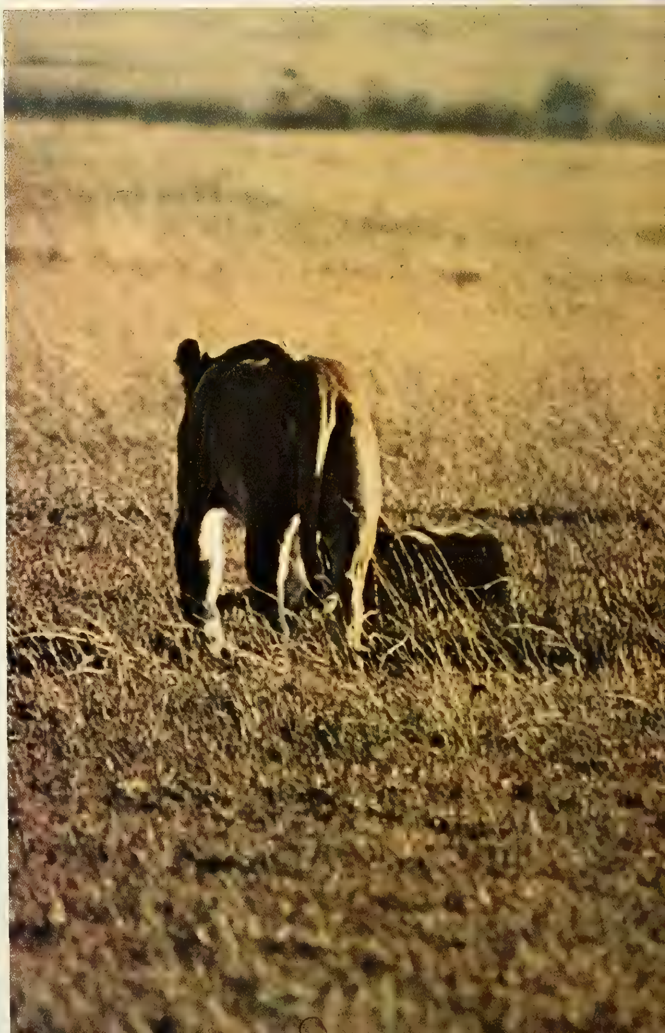
Buffalo may defend themselves against lions and may even attack in return. On two occasions, the Masai pride surrounded a solitary bull while he stood facing the lions, his rump against a tree. Some twenty minutes later, he walked off unmolested. When a male lion rushed at a solitary cow buffalo he had surprised in a thicket, she ran into a nearby stream and stood in the water facing him. He left. She had a large raw wound on her back, undoubtedly the result of an earlier lion attack. Wounds on the shoulders and back of buffalo are not infrequent and these attest to the difficulty that lions have in subduing the animals.

I observed seven attacks on buffalo, of which one was successful. At eight o'clock one morning, I found fourteen lions of the Magadi pride at the edge of a marshy area about twenty yards from a bull buffalo standing belly-deep in mud and water. Deep lacerations covered his muzzle and rump, his hocks were shredded, and his shoulders full of bites, all the result of an earlier at-

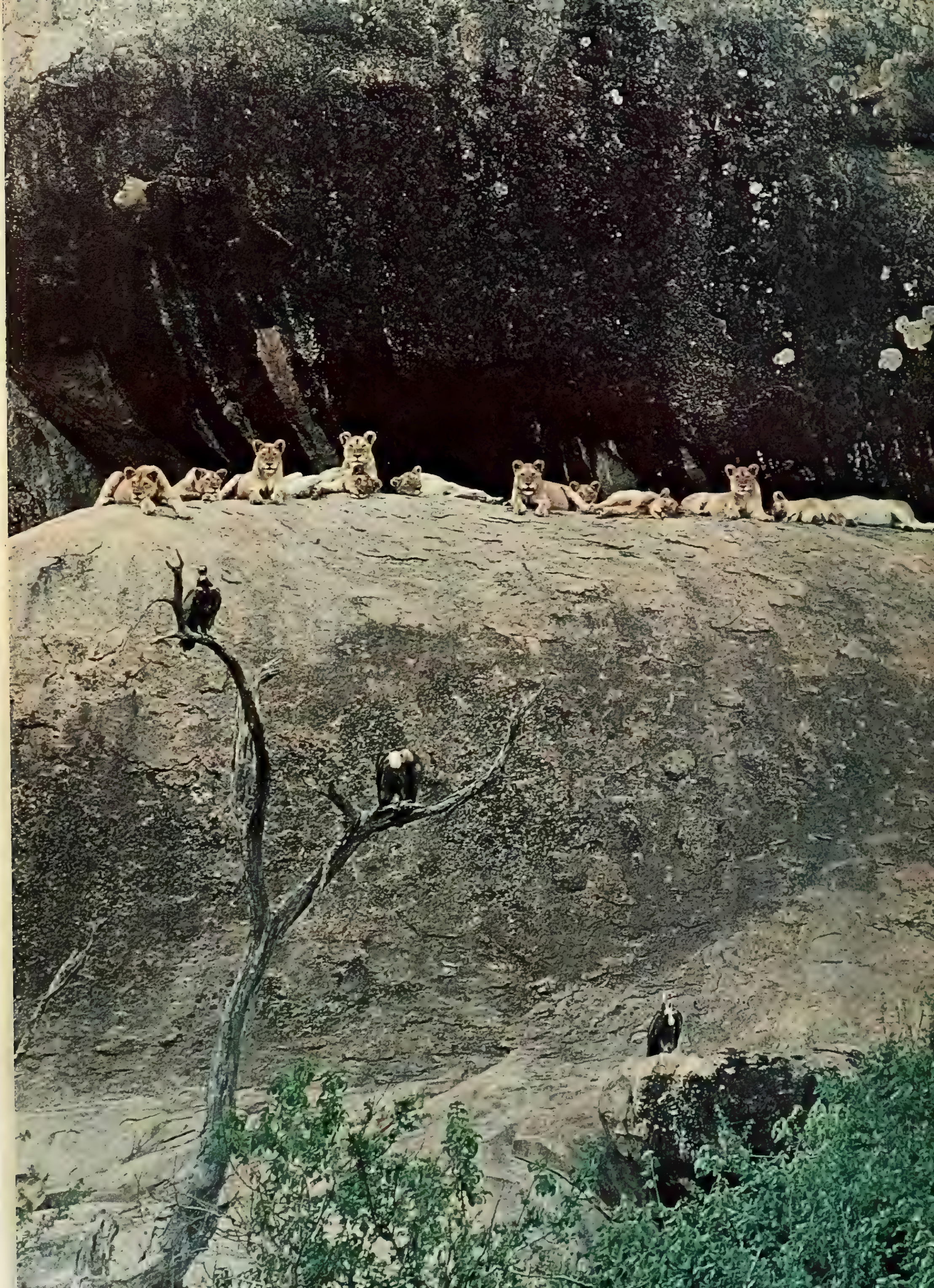
A cub plays with the remains of a freshly killed zebra on the Serengeti. Lion social organization is crucial for the survival of many cubs.


tack that morning. He faced the lions and grunted each time one moved. One lioness approached to within five yards of him but retreated when her paws got wet. At 9:25 A.M., five nomadic males chased the pride away; then returned to the buffalo at 10:10 and lay six to ten yards from him. Fifteen minutes later, he walked slowly toward the lions, a suicidal gesture. One male grabbed his rump; another placed a paw over his back and bit his shoulder. The buffalo sank to his knees. A lion then clambered up on the lower back of the animal, bit him there and leaned to one side as if attempting to turn him over. Meanwhile the other lion first licked blood off the old wounds on the buffalo's shoulder, then bit there again. The buffalo bellowed, yet made no attempt to defend himself. The two males then pulled him on his side, slowly, methodically, without violent movements. One grabbed a foreleg and turned him fully on his back. The third and fourth males joined; one bit the buffalo in the throat, the other held the buffalo's nose and mouth shut with his teeth. The fifth male did nothing. After ten minutes, at 10:40 A.M., the buffalo died.

In general, social attributes assist lions in obtaining food, the single most important requirement in their day-to-day existence. Several individuals are more successful as hunters than is a lone lion, and they are also able to kill larger prey. Because hyenas are less likely to drive



Dense vegetation along river banks provides cover for stalking lions, which kill many buffalo near streams, far left. Small cubs usually stay with the pride. sometimes playing, left; at other times they join the group on a hunt, below. They usually stay a short distance behind when the lionesses stalk prey.



them off a carcass, groups of lions use their food more fully than individuals. Furthermore, in a group, one lion can guard a kill from vultures while the rest seek water.

The evidence indicates that a close relation exists between the exploitation of a food resource and the type of social organization. Lion prides are adapted for hunting large prey cooperatively in open terrain, but their social organization has retained a flexibility that enables individuals to change from social to solitary hunting depending on the available prey.

The core of a lion pride consists of a closed society of lionesses all directly related to each other. Among females, small cubs often serve as a cohesive force to keep the animals together, especially when several litters are born at the same time and their care becomes a communal affair. Although young seem to have no special relationship with the mother after she has a new litter, for those that remain in the pride, contact with her endures for life.

In addition, each pride contains one to four males; these are often individuals that have grown up and acquired a pride together. But the males are not permanent pride members. Of the twelve prides I studied, only three had the same males at the end of three years. The other males either left the pride or were forced out by nomadic males, which then generally took over the lionesses' territory.

Pride lionesses confine their wanderings to a limited area of some 8 to 150 square miles, all or part of which constitutes a territory in the sense that other lions tend to avoid it or are driven away by the owners. Nomads, who do not belong to a pride, roam widely, some over 1,500 square miles and more of terrain. Their contacts with other nomads tend to be amicable. A few males establish temporary territories on the plains, and with the acquisition of property they become intolerant of others.

A pride rests on one of the granite outcroppings, called kopjes, that stud the Serengeti. Vultures closely follow the lions' activities.

What survival value does retention of a territory have for a lion? Given the tendency of pride members to scatter widely, the pride would not be able to maintain itself in its present form if it assumed a nomadic existence: the animals would either have to remain together like wild dogs or wolves or limit themselves to shifting and casual contacts in the manner of nomadic lions. Several advantages accrue to a resident. Territorial behavior is a potent spacing mechanism that allows for a more uniform and socially less disruptive use of food resources.

The flexibility of the lion pride within its territory enables it to harvest both small and large prey more efficiently. When the large herds migrate out of the Seronera area, for example, the pride disperses and the lionesses feed primarily on small game. When the herds return or when the lions hunt buffalo, the members of the pride rejoin for the advantages of group hunting.

Detailed knowledge of waterholes, river crossings, ambush places, and other localities probably increases a lion's hunting success.

Although nomadic lionesses seem to give birth as often as do resident ones, they manage to raise few cubs, indicating that communal care of young in a pride increases reproductive success. This fact alone would favor selection of a stable land tenure system.

Males are inefficient hunters, and they let the lionesses kill whenever possible. The pride, in effect, becomes a meal ticket for the male. In a communal hunt, males trail behind the lionesses, watching and waiting, and when prey is caught they run up and try to claim a large share. While males have been denigrated in the popular press for such behavior, it serves two useful functions: (1) Their large manes make them so conspicuous that their participation would increase the chance of the group being detected by the prey; and (2) with the males in the rear any cubs that are there are protected from marauding hyenas and other dangers.

After a kill has been largely consumed, a male often takes the remains and prevents lionesses from eating. But he does allow cubs to feed, and if they arrive late at a kill, this may be their only meat. Lionesses are less generous than males in sharing and even starving cubs are cuffed away.

The main role of a male is to maintain the integrity of the pride area, either by escorting intruders out or, by his mere presence, inducing them to move on. Although lionesses take part in territorial displays, males are the most active in patrolling, scent marking, and roaring. The Seronera pride illustrated the importance of males to the pride. One evening I met the males of the Seronera and Masai prides near each other in an overlapping part of their range, which raised the possibility of conflict. The following morning at 6:35 I found one of the two Seronera pride males encrusted with blood. Tatters of his yellow mane were strewn around his body, his left thigh was ripped to the bone, and punctures covered his body. He breathed heavily. At 6:55 a male from the Masai pride walked slowly to within five feet of the vanquished male, and receiving only a baleful glare and a low growl, ambled off. By 8:30 the breathing of the wounded male grew erratic and spasms racked his chest. At 8:35 a muscle in his right thigh quivered, and his pupils became very large, his last movement.

Males from three other prides then penetrated deep into the Seronera pride area, killed several cubs, and drove out the remaining male. The lionesses remained, but their success in keeping cubs alive was much lower (19 percent) than that of a neighboring pride (46 percent) that was under the jurisdiction of vigorous males. It was two years after the death of the male before the pride settled down to a normal social life.

(Continued next month)

Sky Reporter

by John P. Wiley, Jr.

Intelligent Life in the Universe Out here in the galactic boondocks, we tend to think of ourselves as being alone. The trading ships never stop, scientific teams and tourists keep a discreet distance; we are not even hooked into the regional radio network. At federation headquarters, Earth's file is stamped: "Emerging technological civilization: Survival doubtful."

Nevertheless, in the midst of wars, genocide, social revolution, and general bedlam, some people on Earth are quietly turning their thoughts out to the galaxy. Patiently they swing radio telescopes from one likely looking star to the next, straining their equipment to pick up signals from other worlds. Sooner or later they will succeed. The signals will come in, clear and strong, unquestionably the product of intelligent life from another part of the universe.

Fearing invasion by green monsters, our first reaction may be to turn to the military. But if we stop to think, we will realize that our having heard "them" will not, in itself, reveal our presence to them. We will have all the time in the world to decide whether to answer, and how to answer if we do. We probably have more to gain than lose by answering. It is highly unlikely that another race of intelligent beings would come to Earth for conquest, plunder, or enslavement, the motives that spring immediately to an earth mind. The odds are that the other civilization would be far in advance of our own, socially as well as technically, and overnight, we could learn from them what might otherwise take us centuries.

Despite the protestations of flying saucer enthusiasts, we have no unequivocal evidence that the earth has ever been visited by beings from another world. Radio pioneers Marconi and Tesla claimed to have heard signals from another world, but no one has since made a similar claim. It seems little short of certain, however, that someday, somewhere in the world, a news story not unlike that predicted in 1900 by Tesla will burst upon the world: "We have a message from another world, unknown and remote. It reads: 'One . . . two . . . three.' "

Consider the numbers. Our galaxy is only one of billions; yet in our galaxy alone, several hundred billion stars are shining. To suppose the sun is the only star accompanied by planets, and that our planet is the only one on which life emerged, smacks a bit of the medieval church, which put men to death for daring to suggest that the earth was not the center of the uni-

What do 100 billion stars look like? This neighboring galaxy, M31 in Andromeda, is believed to give a good idea of what our own galaxy looks like. At a higher resolution, the white clouds become swarms of stars; the bright core at the center is really millions of stars packed together. The two small spheres of light are satellite galaxies. All the other stars in the picture are in our own galaxy; we are looking out through them toward M31.

verse. It has only been in the lifetime of men still living and working that we have figured out where we stand in the galaxy, and where the galaxy stands in this part of the universe.

The numbers argument was put in cogent form by Harlow Shapley, one of the first to accurately measure the galaxy. He calculated that if only one star in a thousand had any planets at all, and if only one in a thousand of these had planets at a suitable distance, and if an atmosphere developed on only one in a thousand of these, and if the right chemicals were present in the oceans and atmospheres of only one in a thousand of these, we would still be left with a hundred million planets suitable for life. And that's just in our galaxy.

Other arguments for the existence of planets around most stars are based on observation. The evidence is necessarily indirect; even the nearest stars are so far away that any planets circling them would be lost in the stars' glare and we could not see them.

In our immediate neighborhood, most of the stars are members of multiple systems of one sort or another. Either they are double or triple systems or they are stars with "unseen companions" pulling on them as they move through space.

These are the stars we can see best. Of the 59 stars within 17 light-years of the earth, for example, 22 are doubles and 6 are triples. At least 7 of the 59 stars are accompanied by dark companions.

The best-known case is Barnard's Star, which apparently has one or two planets about the size of Jupiter revolving around it. We cannot see the planets, but we can measure their effect on their star. From Kepler's laws of motion, we know how far from the planet they must be; knowing that, we can judge how massive they are by measuring their effect on the star.

Even nearby dark companions can be detected only when they have great effects on a visible star. Planets the size of the earth cannot be detected in this way. Thus, because we can detect only the most obvious cases, it is doubly significant that seven of the closest stars have unseen companions. Presumably there are more.

Another line of evidence is even more striking. All the stars we can see, including the sun, rotate. We know this about distant stars because their spectral lines are slightly spread out. As we look at a star, the light from the edge coming toward us is shifted slightly toward the blue end of the spectrum; light from the receding edge is shifted slightly toward the red. By measuring the spread, we can discover how fast a star is rotating.

The interesting thing is that while some kinds of stars rotate very rapidly, others, including the sun, rotate slowly. Astronomers customarily range stars on a scale from very hot to very cool, designating them, in order, O,B,A,F,G,K, and M. The hot, massive stars, from O to A, all rotate rapidly: a point on their equator moves several hundred miles per second. But in the F stars there is a sudden, sharp break in the pattern. All the cooler stars—from that point down to the coolest visible stars—rotate at a much slower rate, on the order of a mile or two per second. The sun, a G star, has a rotation rate of some 1.5 miles a second.

As far as we know, all stars formed in the same way, condensing out of clouds of gas and dust. As they condensed, the clouds began to rotate; and the smaller they became, the faster they rotated. This faster rotation results because the total rotating energy is conserved. Figure skaters know they can spin faster with their arms tucked in close to their bodies; high divers know they can do more somersaults if they curl into a ball. In exactly the same way, a shrinking rotating cloud spins faster and faster.

But rotational energy can be conserved by allowing some of the weight to revolve at a distance from the center. When the cloud that was to become the solar system condensed, some of the rotational energy was left in the planets, especially Jupiter. Thus the sun rotates at a much slower velocity than would otherwise be the case.

More than 90 percent of the stars we can see, even with our largest telescopes, are F or cooler on the stellar scale—O,B,A,F,G,K,M—and rotate with very small velocities. Of the 59 stars nearest the sun, no fewer than 39 are cool, red M stars. Many astronomers

are drawing the conclusion that the vast majority of stars rotate slowly because they have invested much of their rotational energy in planetary systems.

If most, or all, stars are accompanied by planets, then the number of stars in the observable universe is roughly the number of solar systems containing one or more planets. If we take as a conservative number for the stars in our galaxy, 100 billion, and multiply it by a conservative number for the galaxies in the universe, a billion, we get 1 with 20 zeroes after it as the conservative number of solar systems in the universe.

A number like 100,000,000,000,000,000,000 is pretty meaningless. A quick calculation might bring it into better focus. If solar systems have formed at a steady rate since the beginning of the universe, and if the universe is 10 billion years old, as is generally accepted, then a million solar systems are being formed every hour.

Not all planets, of course, would be habitable by life as we know it. Some would be too close to their star, and thus too hot; others would be too far away, and thus too cold. Some would be too small to retain any type of atmosphere. Some would move in orbits so eccentric, or would be so tipped to the plane of their orbit, that seasonal extremes of temperature would preclude life. A planet might not be old enough for life to have arisen. Or it might circle a star that will not last long enough for life to arise.

Even with all these constraints taken into account, we are still left with a lot of planets that could support life. In a study for the Rand Corporation, Stephen Dole offers one of the best educated guesses to date about our galaxy: six hundred million planets. Averaged out over the galaxy, this number means that there is at least one habitable planet within 27 light-years of the earth, 5 within 47 light-years, 10 within 59 light-years, and 50 within 100 light-years, all close enough for us to be able to signal back to them with our present technology.

All this number juggling is interesting, but is anybody really out there? What are the odds that life has arisen on any of these myriad hypothesized planets?

We have no sure way of knowing. Proof that there is, or was, even bacterial life on Mars would be powerful evidence that where life can arise, it will. But Mars is very cold, with little water or atmosphere; failure to find evidence of life there would not be a conversely powerful argument against life being a common phenomenon in the universe. As a habitable planet, Mars is marginal at best.

The main argument for life elsewhere in the universe is that the physical laws we are familiar with on earth operate as far as we can see, or some ten billion light-years. The same physical processes, involving the same elements, are going on all around us. We have no reason to disbelieve that the chemical evolution of life is also going on all around us.

We think we know how life arose on the earth. In fact, we have been able to duplicate crucial steps in the laboratory. Electrical discharges (simulated lightning) set off in atmospheres believed similar to the primitive earth's (methane, ammonia, water, and hydrogen) produce large numbers of amino acids. Running the experiment long enough produces further combinations, sugars, nucleic acid bases, and long chains of amino acids that resemble proteins.

When molecular systems reach the level of complexity at which they can reproduce themselves and affect their environment, then life—and evolution—has begun.

It now appears that the prerequisite chemical evolution can start at a fairly complex level. Biological precursors may have existed at the time a planet was formed. Recent work with radio telescopes has revealed the presence of water, ammonia, and a whole catalog of hydrocarbons in interstellar clouds. Amino acids have been found in meteorites.

Even if life has in fact blossomed all over the universe, it is still not clear how many planets would boast populations both intelligent and technological. Whether any given life form is intelligent, of course, depends on your definition. All that is meant here is the ability to think and to communicate. By technological is meant the ability to communicate across astronomical distances. It seems not only possible but probable that many life forms elsewhere are intelligent without being technological; in those cases, however, we could not communicate with them unless we physically went to them.

The technological civilizations pose their own problems. Based on our experience on earth, it seems reasonable to assume that technological civilizations may not last very long. Or, more optimistically, that if they can survive the first few decades after having unleashed nuclear fission and fusion, they may then survive for eons. We have no way of knowing—yet—which is more likely to be the case. (We could find out any day now that the lifetime of at least one technological civilization in the universe was in fact measured in decades.)

The best guess is that some civilizations make it and others do not. In their book on life in the universe, the Soviet astrophysicist I.S. Shklovskii and the American planetologist Carl Sagan estimated that technical civilizations either last less than 100 years or a good deal more than 100 million years. Striking an average of a million years for their computations, they then deduced that the number of technical civilizations in our galaxy is one million. The most probable distance between such communities would then be several hundred light-years.

So here we are, floating around the outer reaches of the galaxy, blissfully unaware of all the other civilizations that also call the galaxy home. We did listen for signals for a few months in 1960, and now we are listening again. So far, we have heard nothing.

The odds are very high, though, that someday we will receive a signal from another world. That signal could have been sent a century ago, and may just now be approaching the solar system. We might hear it tomorrow or a year from now or not for another century. It will not make much difference whether we answer or not: in effect, we answered 40 or so years ago when we first started using high-frequency radio trans-

mitters. Those radio waves have been traveling across interstellar space ever since, and sooner or later they will be picked up. We will have announced to the galaxy that we have achieved a technological civilization. If the nearest civilization turns out to be less than 40 light-years away, their reply may already be headed toward earth. If they are farther away, they have not yet heard from us. But they will. And we will hear from them.

On to Jupiter To date, man's exploration of space can be likened to that of a group of people living on a small island in a warm lagoon who have so far been able to row across to one nearby, smaller island and to sail small model boats to other islands in the lagoon.

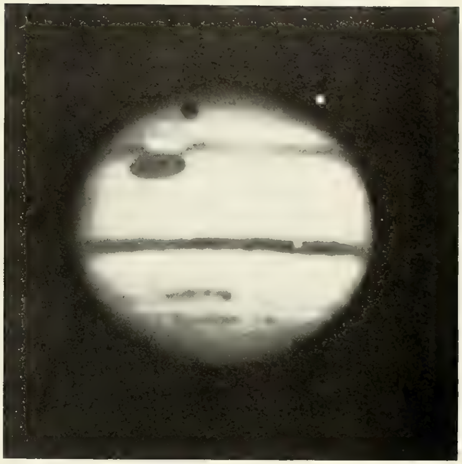
Now, for the first time they are preparing to sail a model past the rocky reef that surrounds their lagoon to one of the larger islands outside. They do not expect to go there themselves for years to come, but they hope that by watching the model they will learn something about the reef, the intervening tides and currents, and the great island outside.

In other words, for the first time man is headed out across the rubble-strewn asteroid belt to Jupiter, the first—and grandest—of the giant planets. A 550-pound electronic spider called Pioneer F will be lifted off Cape Kennedy in late February or early March and flung away from the sun at better than 32,000 miles per hour. Six hundred to nine hundred days later, if it has not been demolished by an errant planetoid, the Pioneer will take about a week to scoot by Jupiter—snapping pictures like mad—and then corkscrew all the way past Pluto and out of the solar system into the deep space dividing one stellar island complex from the next.

The Pioneer faces a 10 percent chance of being severely damaged or destroyed while going through the asteroid belt. There are some 50,000 asteroids, ranging in size from 480-mile Ceres down to unnamed rocks a mile across, and an unknown number of smaller fragments: all told, enough to make a small planet. Whether this year's Pioneer makes it or not, another will be launched in April, 1973, doubling the chances of success.

Once in the vicinity of Jupiter, the spacecraft will face real danger from powerful radiation, trapped in belts around the planet, that could destroy sensitive instruments. No one will be upset if the instruments are destroyed after the data are radioed back from Jupiter to the earth: Pioneer's radio is too weak to be heard from much farther away.

For planet buffs, going to Jupiter is worth the gamble. Jupiter differs in kind from the inner terrestrial planets and can even be considered a small, feeble star, rather than a planet at all. It is 11 times larger than the earth and "weighs" 318 times as much. For all its size, Jupiter spins much faster than the earth: a point on its equator moves at 30,000 miles per hour, while a similar point on earth moves at a mere 1,000 miles per hour. More importantly, Jupiter is a few degrees hotter than it should be at its distance from the sun, leading to speculation that it is a borderline star, generating its own heat in pale imitation of the sun.



In this photograph of Jupiter, taken in blue light with the 200-inch telescope on Mount Palomar, the Great Red Spot appears as the dark elongated oval at upper left. Just clear of Jupiter's disk at upper right is Ganymede, one of the Galilean moons; its shadow is the dark circle near the top of Jupiter.

We do not even know whether the surface of Jupiter is solid, liquid, or gas. We have no idea what will explain the Great Red Spot, thousands of miles across, which wanders among the slate-blue and salmon-pink bands of Jupiter's upper atmosphere.

We would like to know more about the bursts of radio noise Jupiter emits, some of them apparently triggered by Io, one of the four Galilean moons. We would like to know more about the moons themselves, three of which are larger than the earth's moon and one of which is believed to have an atmosphere.

The lack of facts has encouraged speculation about the giant planet. Some have proposed that there could be life in Jupiter's upper atmosphere, perhaps in the form of balloonfish, floating around and sucking in nutrients like so many jellyfish filtering the water of a terrestrial ocean.

The Jupiter missions are billed by NASA as warm-ups for the Grand Tours later this decade. The tours are missions in which spacecraft would take advantage of the fortuitous temporary lineup of the outer planets, so that they would be pulled in by one, only to be flung on to the next in a kind of gravitational "crack-the-whip." But even if the Grand Tour missions are scrapped (and there is a real debate over whether they are the best way to spend the money), Jupiter is more than worth two trips in its own right. ■

Celestial Events

by Thomas D. Nicholson

With new moon at midmonth in February, expect to see the waxing crescent in the western sky during evenings from the 17th on, with first-quarter moon on the 21st. The moon, full on the evening of February 28, reaches last-quarter on March 8 and becomes new on March 15.

The three evening stars—Venus, Mars, and Saturn—continue to move closer to one another during late February and early March; Venus brightens but both Mars and Saturn become dimmer. Venus, by far the brightest, may be seen in the southwest from midtwilight to shortly after dark. Mars is well to the left and higher than Venus and can be distinguished by its reddish light. It sets before midnight. Saturn, still farther to the left among the stars of Taurus, is well up toward the south in the early evening and sets about midnight. In the morning sky, Jupiter rises in the east several hours before the sun and fades into the morning twilight. Toward mid-March, Mercury can be seen as an evening star, low in the west after sundown.

February 17: Mercury is at superior conjunction, beyond the sun as viewed from earth, moving from right to left past the sun. The planet now enters the evening sky.

The waxing crescent moon will pass north of Venus after both have set for most mainland United States viewers. The bright planet becomes visible during early evening twilight well below and to the left of the moon, low in the southwest.

February 19: At twilight this evening, the moon is passing from right to left above Mars, well up in the southwestern sky. Look for the planet almost directly below the moon as it grows dark. It is easy to pick out among the relatively dim stars of Pisces, the constellation of the Fishes. The moon will have moved farther to the left of Mars by the time both set before midnight.

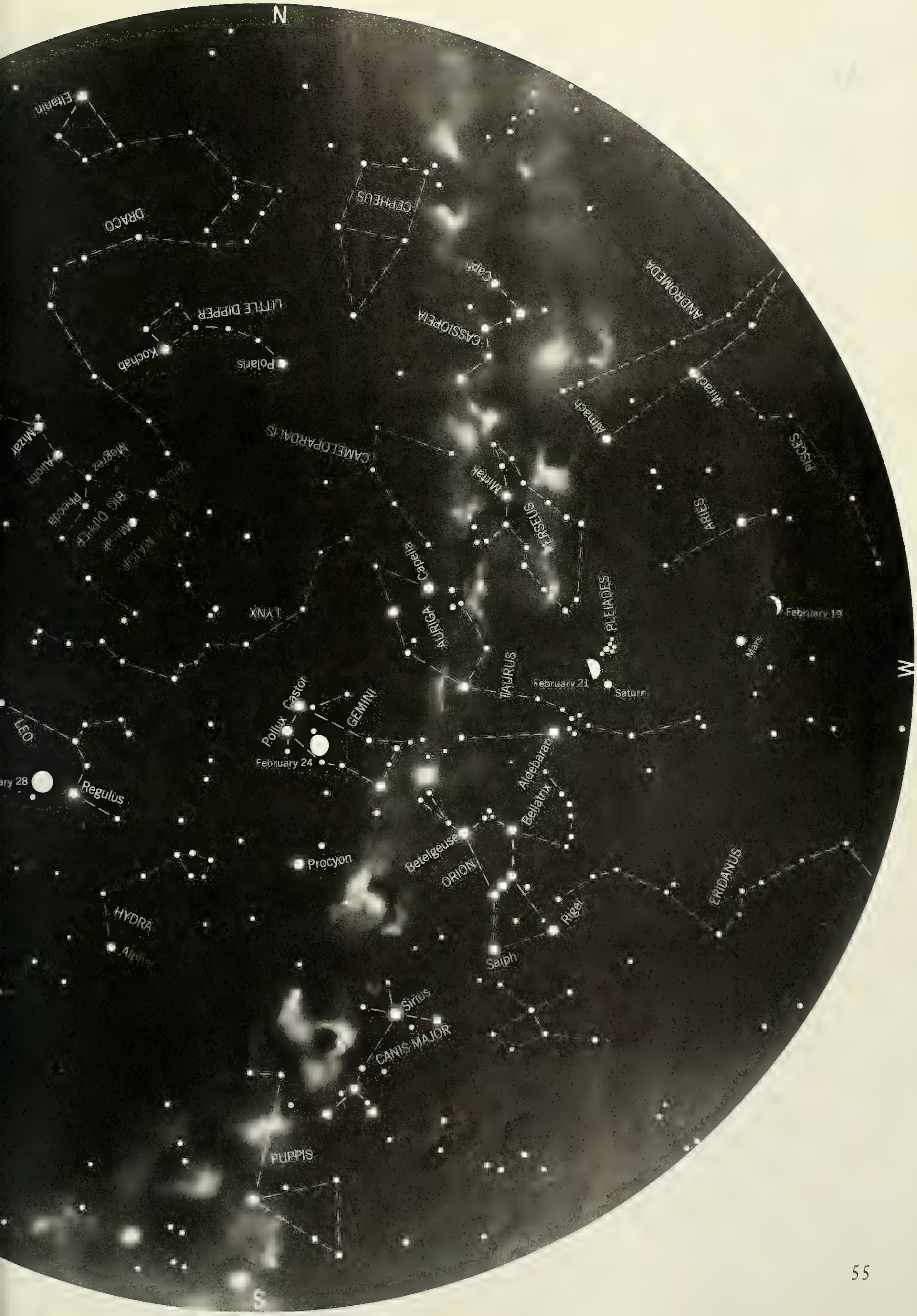
February 20-21: The moon passes through Taurus, and in so doing moves past the planet Saturn. On the evening of the 20th the moon is well to the right and above Saturn. By the evening of the 21st, when it has just about reached first-quarter, the moon is to the left and closer to Saturn as both become visible in late twilight. The moon moves away to the left during the night.

March 7: The moon, near last-quarter, passes close to Antares, the brightest star in Scorpius. Again, as it does each month this year through September, the moon occults Antares, this time as seen from the eastern Pacific and Central and South America. The star will be found just to the left of the moon in the sky this morning.

March 9-10: Look for Jupiter to the left of the crescent moon in the morning sky. On the morning of the 10th Jupiter will be to the right of the moon and higher.

March 14: Mercury is at greatest elongation in the evening sky, 18 degrees to the left of the sun. This is a relatively favorable elongation, and the planet may be found low in the east during early twilight for several days before and after the 14th.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:15 P.M. on February 15; 9:20 P.M. on February 29; and 8:25 P.M. on March 15; but it can be used for about an hour before and after those times.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ARIES
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AURIGA
PLEIADES
February 19
Mars
LYNX
TAURUS
February 21
Saturn
Castor
Pollux
GEMINI
February 24
LEO
Regulus
Aldebaran
Bellatrix
Procyon
Betelgeuse
ORION
ERIDANUS
HYDRA
Rigel
Saiph
Sirius
CANIS MAJOR
PUPPIS

A New World for the Cattle Egret

A small, sociable egret from Africa has rapidly filled a niche in pastures from South America to Canada

by William J. Weber

Glancing anxiously at the sky, a ship's crewman sailing a stormy South Atlantic in 1877 might have noticed a flock of white birds, cattle egrets from Africa, whizzing by on their way to the New World.

Unfortunately no such sighting was ever recorded, so we do not know exactly how the cattle egret reached South American shores; it is even possible that they flew the distance without the helping winds of a storm. What is known is that they were first recorded in Surinam between 1877 and 1882, and their presence there is generally accepted as an example of natural extension of range, that is, expansion unaided by man's activities.

The ecological implications of such colonization are many. There is the immediate question of the bird's survival in a new area and, if successful, its impact upon local species. Other, long-range questions center on the bird's ability to expand farther into other suitable areas and on the effects the invader has in those ecosystems. These same questions apply to the relatively frequent expansion of certain animal populations through the purposeful or inadvertent actions of man. Introductions of this type have generated much attention because they have sometimes had negative ecological effects.

Answers to some of the questions concerning the presence of the cattle egret, *Bubulcus ibis*, in the New World have long been known. The bird did breed successfully, and after years of consolidation began to spread rapidly over much of northern South America and southward into Brazil. But its greatest territorial gains were made to the north. Colonizing its way through the Caribbean, it appeared in south Florida by the 1940s, and the first nesting of cattle egrets in that state was reported near Lake Okeechobee in 1953. Today, they are found throughout most of the eastern states, all along the Gulf Coast into Texas, as far west as California and Washington, and up into New Brunswick and Newfoundland. Nesting has occurred as far north as Ontario. Cattle egrets have also spread into many other areas throughout the world where they were formerly unknown—over most of southern Africa and Europe, Southeast Asia, and Australia. Such an extensive geographical expansion in a relatively short period of time is exceptional.

Studies of animals that have increased their natural ranges—an indication of biological success—can help man attain better insights into the processes of evolution. This was emphasized by Andrew J. Meyerrieck in his article on the cattle egret, "Success Story of a Pioneering Bird," NATURAL HISTORY MAGAZINE, August-September, 1960.

Few studies had been made on the bird, however, and Meyerrieck called for further biological research to provide the data necessary to interpret the success of this species. To demonstrate the lack of basic information available at the time, his book *Comparative Breeding Behavior of North American Herons*, published in 1960, lists forty of the fifty behavioral patterns of the cattle egret as unknown. To learn more about them, I began studying an island rookery in central Florida, where I was able to observe the courtship, breeding, incubation, hatching, and brooding activities of the nesting birds.

My daily movements to the blind soon revealed one factor that may help to account for the successful reproduction of the cattle egret. Each time anyone approached the island or the blind, there was considerable alarm-call vocalizing, flying, and complete disruption of courtship, breeding, and nesting patterns. A great deal of confusion ensued as they fluttered away from their nest sites, but almost as soon as the potential threat disappeared, they returned to their nests and resumed normal colony activities. Af-

Vociferous greetings are exchanged at the nest when a cattle egret takes over incubation so that its hungry mate can feed.

ter the fourth or fifth visit all the birds would be back at their nests within four to ten minutes, in contrast to other species of herons nesting in the area, which never accepted my presence. This degree of nesting stability is important to the eventual survival and successful spread of a species.

Courtship in this colony begins in the middle of April. A few birds staying around the island during daytime hours, rather than leaving to feed, is the first sign that a change is occurring in their daily routine. At this time the birds have the normal appearance of cattle egrets: yellow beaks, yellowish orbital skin around the eyes, and yellow lores, or spaces between the eye and beak; their feathers are snowy white with a brownish wash on the top of the head, the chest, and the back. The color of their legs ranges

Because plumage is not a reliable guide and nest duties are shared, mating must be observed to identify the sexes in the field.

The firstborn chick has the best prospect for survival since it learns to feed and attains maturity before its nest mates.

from yellow-green to almost black.

As hormones are set in motion with the approach of the breeding season, there is a dramatic change in the bird's appearance. The basal area of the beak begins to show a reddish tinge, and in the space of one to two days the beak becomes bright scarlet, with a burnished golden tip. The lores and the orbital skin become a scarlet-fuschia color and the irises change from yellow to bright red with an inner ring of yellow at the pupillary opening. Legs become bright scarlet, and the brownish-tan wash of the feathers seems more intense. The snow white of the body feathers accentuates all these colors.

As the birds paired up and selected nest sites in the sprawling clumps of Florida elder, I was unable to differentiate males from females. Intensity of the color changes was not a reliable indicator as some females were more completely and intensely colored than the males. Assuming, as with most herons and egrets, that it is the male bird that establishes the nest site, I could guess which should be the male, but it was only when the birds were actually mating that I knew positively which one was. By the following day, however, color pattern and intensity often varied enough so that copulation would have to be repeated before I could again establish which was the male.

Mating takes place at the site selected for, and during actual construction of, the nest, a rather shabby affair of reeds, stems, and elder twigs. It is the male who initiates copulation by grasping a heavy twig with his beak and shaking it vigorously. If the twig is in the nest itself, the shaking is not violent enough to dislodge it, but is sufficient to attract the female's attention. At this signal the female, with much vocalizing, descends to the nest and is mounted by the male for five to six seconds. After copulation, the male usually repairs to a nearby limb, preens awhile, then leaves to gather twigs for the growing platform that will be the pair's nest.

Breeding and nest building usually cover a period of three days. The colors of the breeding plumage are at their peak during this time, with bright hues contrasting against tan and white. Equally striking is the rapid color change back to normal plumage once the first egg is laid. Within 24 to 48 hours, almost all the red color is gone and the only lingering sign of the breeding period is an orange tint to the legs,

When a cattle egret chick clasps its parent's bill, the adult regurgitates food to satisfy the young bird's ravenous appetite.

which also disappears in another day or so. Paralleling the fading color is a diminution of breeding activity.

A light blue egg is laid every other day until there are two to four in the nest. Incubation is shared by the pair, with a series of vocal greetings accompanying the exchange of nest duty. Since one of the parents is constantly attending the eggs, there is little opportunity for predation by other birds, another factor that helps insure successful reproduction.

The eggs hatch in 24 days, and the young, averaging 20 grams, or two-thirds of an ounce, in weight are also fed and brooded by both the male and female. While the chicks are still quite small one parent always guards the nest while the mate is off foraging. Vocal greetings, identical to those used during the incubation period, are again exchanged upon the forager's return. The newly arrived adult, which has been feeding upon insects disturbed by livestock grazing in the nearby fields, stands on the edge of the nest while its mate flies off to feed.

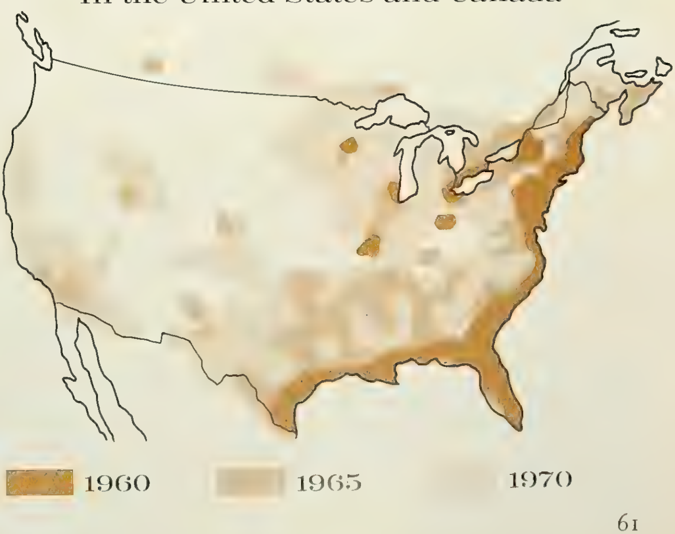
Since the eggs are laid at two-day intervals, the chicks hatch at two-day intervals, giving the firstborn chick a decided advantage over those that follow. It learns to eat first, begins growing at once, and maintains a decided maturity advantage over its siblings throughout the brooding period. To demonstrate this advantage and its significance, weights of three chicks, which hatched on May 11, 13, and 15, respectively, were recorded. At birth they weighed 21 grams, 22 grams, and 22.4 grams. By May 16, the last hatched was still about the same size, 23 grams; the second born had more than doubled its weight to 49 grams, and the firstborn had tripled its weight to 64.5 grams. The smallest seemed to stay the same size; four days later it was missing from the nest. I weighed the two remaining birds again on May 25 and the firstborn had ballooned up to 168 grams, with the May 13 chick also registering a substantial gain to 143.5 grams. The missing chick was found at this time—dead, squashed into the twigs making up the floor of the nest. This pattern was repeated in nest after nest. In only two of the twenty nests under observation were three chicks raised. Most parents raised only two chicks, the youngest chicks had either been forced out or killed by their nest mates. In nests where there were only two eggs, usually only one bird was raised to fledgling.

For cattle egrets, as well as for some of the other herons and egrets, the advantage of the firstborn is a significant factor in survival. Under normal food conditions an average of two vigorous chicks are usually raised, and in periods of food abundance, three or more birds may be successfully fledged. But in times of severe food shortage, a pair of cattle egrets will have a better chance of raising at least one strong chick. Certainly from a survival standpoint it is better to raise one healthy replacement than two or three weak, malnourished birds. A natural process of selection, based primarily on food availability, insures that replacements will be strong and vigorous.

Feeding the young chicks is accomplished by the adults touching the chicks' beaks with a regurgitated food bolus, or wad, stimulating them to peck away at the offering. Whatever is not eaten or left on the nest is reswallowed by the parent. As the chicks get older, they become more aggressive eaters. Adults bringing food to the nest are grasped by the beak and their heads pulled down to hasten regurgitation. Competing for the food, the strongest chicks frequently drive the smaller ones away from the feeding parent, and the weakest ones die.

Soon the surviving chicks are able to intercept the regurgitated material before it can fall into the nest. They cry demandingly all during the feeding process, flapping their stubby, featherless wings in typical begging postures, and repeatedly grasp the parent's beak, pulling its head down to the nest in

Range Extension by Cattle Egrets In the United States and Canada



hopes of stimulating more output. They swallow boluses the size of their own heads, and never seem satisfied, regardless of the amount they consume.

At six weeks of age the chicks appear to be as large as their parents. They attack the adults so aggressively that the feeding process resembles a fight. So violent does the feeding become that often the parent and chick fall to the ground in a white swirl of feathers as the chick attempts to wrest food from the battered parent.

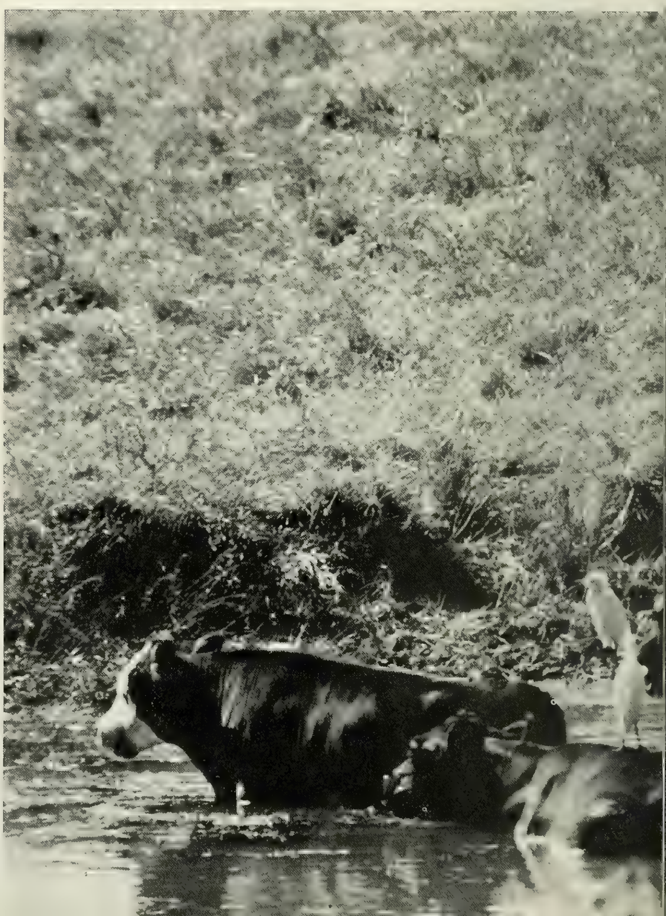
At this stage both adults forage constantly during the daylight hours for food for the ever hungry chicks. Alone at the nest site most of the day, the chicks stay in the immediate nest area even though they are now capable of flight. They move about on the tops of the elder trees, the better to intercept the adults as they come bringing food for the ravenous brood. The chicks can recognize their parents among the many flying, milling, similar-appearing adults while they are still some distance away from the nest. Vigorous and aggressive, they fight off young birds their own size and even adults that invade the territory of the nest site.

Another crucial factor helping to insure the survival of the species is the extended nesting period of the colony. Even in July, some late-blooming cattle egrets were breeding and establishing nests. Such a long breeding season helps prevent any catastrophic loss of the breeding colony or nestlings from natural phenomena such as heavy windstorms or torrential rains. A portion of the nests and nestlings might be lost, but the colony would still be viable.

All of these factors taken together help explain why the cattle egret is a biological success and is spreading rapidly over the Northern Hemisphere.

Also, observations of this colony indicate that this success has not been at the expense of native herons and egrets. Sharing the island with the cattle egrets were nesting Louisiana herons, snowy egrets, and anhingas. Nests of the snowies and Louisiana herons were built as close as six inches to cattle egret nests. They got along as neighbors unless the immediate nest territory was invaded, an action that would precipitate some threat posturing and forceful pecking until territorial limits were re-established. Because cattle egrets nest in compact colonies, they seldom use a large proportion of the suitable heron-egret nesting sites available in any one geographical area.

Competition for food is another extremely crucial factor when attempting to ascertain whether conflicts exist between species in a given area. In this case the feeding behavior of both the cattle egret and native herons is well known. The cattle egret, much more terrestrial in its habit of following wild and domestic cattle, sheep, goats, and whatever other animals graze in pasture and field, snaps up insects disturbed by its larger companions. Some native species of herons feed in a similar manner, but to a much more limited extent; the bulk of their diet consists of fish and frogs



In a Florida pasture, the movement of livestock disturbs enough insects to provide cattle egrets with a steady food supply.

speared in streams, marshes, and along lakeshores.

To further confirm these food habits, Mike Fogarty, a biologist with the Florida Game and Fresh Water Fish Commission, has analyzed the stomach contents of one thousand cattle egrets. None of the fish that make up the basic diet of native herons and egrets was found. The study showed that up to 80 percent of the cattle egret's diet was made up of grasshoppers and crickets, together with other insects such as spiders, flies, and beetles. Earthworms, frogs, and crayfish made up an additional small portion of the diet. In total, invertebrates accounted for 99.8 percent of the food that could be identified and 92 percent of the total food volume. The conclusion has to be that rather than posing a threat to other herons and egrets through competition for available food, the cattle egret occupies a food niche that is not being exploited by other birds.

Normally the cattle egret feeds by moving alongside, and at times under, the feet of grazing livestock, skillfully preying on the insects they stir up. No other bird has developed this specialized feeding technique to the same degree as the cattle egret, so competition from other species of birds has not been significant. And yet, these birds are adaptable enough to follow a plowing tractor or even to use other birds to stir up insects for them. This adaptability may be one of the strongest factors insuring the cattle egrets future survival and expansion.

That this niche was vacant and available is probably the most important ecological consideration for the rapid spread of this species, but also significant is the bird's breeding success. The nesting stability, the incubating, brooding, and feeding of the young by both parents, the dominant survival order of the chicks based on available food, and the long breeding season add up to an evolutionary balance favoring survival.

A bird that functions in the biological control of pasture insects, adds diversity and the contrast of white to the greens and browns of our pasture-studded landscape, and apparently does not compete with our native birds should be classified as a graceful and beneficial addition to the American avifauna.

Out of the Silence

In a burst of creativity, Indians once filled the Northwest Coast of America with totem art. Now these carved cedars are disappearing slowly into the earth that spawned them

by William Reid

When we look at a particular work of Northwest Coast art and see the shape of it, we are only looking at its afterlife. Its real life is the movement by which it got to be that shape.

It is easy to be entranced by the soft curtain of age, seeing this instead of what it obscures. An ugly building can make a beautiful ruin; a beautiful wood carving in the dark of many years, softened by wear, becomes a symbol that tells us that the cycle of life, death, decay, and rebirth is a natural and beautiful one.

This is not what their creators intended. These were objects of bright pride, to be admired in the newness of their crisp curved lines, the powerful flow of sure elegant curves and recesses—yes, and in the brightness of fresh paint. They told the people of the completeness of their culture, the continuing lineages of the great families, their closeness to the magic world of myth and legend.

Perhaps they told more, a story of little people, few in scattered numbers, in a huge dark world of enormous forests with absurdly large trees, of stormy coasts and wild waters beyond, where brief cool summers gave way to long black winters. Families round their fires, no matter how long their lineages, needed much assurance of their greatness. The wonder of it all is that there were so few—a handful of sea-hunters clinging to tiny footholds on the jungle-backed beaches.

But it was a rich land; above all, a rich sea. Millions of salmon returned each year to the rivers to spawn and die, a sacrifice that assured the survival of their kind and at the same time gave easy life to the bear, the otter, the eagle, and a host of others, including a few humans. In a few weeks men could gather enough salmon to last a year. Shellfish clustered on the rocks and sandy bottoms; halibut carpeted the ocean; berries grew plentiful on the bare hillsides. If there weren't enough bare hillsides, a fire on a hot day would provide one for the next year. Sea lion and sea otter, seal and whale and porpoise were everywhere, and all flesh was meat.

In the early spring the rivers swarmed with *oolichan*, the magic fish of the north coast, 90 percent oil, and to those who knew it well, fragrant, delicious oil to enhance the flavor of dried salmon and halibut, to mix with dried

photographs by Adelaide de Menil

Old Kasaan, Alaska

berries, to flavor stews, and to provide most of the nutrients necessary for life in the long, sunless seasons. There were nettle roots and water lily roots and seaweeds, gull eggs, black bear, grizzly bear, deer, and much more, right there for the taking.

If the sea hunt was unsuccessful or smoked fish ran out before the new season arrived, mussels were a dark blue mantle on almost any rock, cockles lay exposed at low tide, abalone and rock oysters could be found with little effort, tide pools yielded delicate sea urchins, the octopus could be flushed from his cave, and clams lay under most beaches. Even today only a stupid man could starve on this coast, and today is not as it was.

Then there was the forest. Nowhere else was there anything like the Douglas fir, the strongest, toughest, in many ways most remarkable wood in the world. Trees six, eight, twelve feet through the butt, forty or fifty feet to the first limbs, two or three hundred feet tall.

They are nearly all gone now, but for a while they provided the beams and uprights and siding for half the houses of America; the supports for many big buildings. But to be used, they had to wait for the white man and his steel axes and saws. They were too tough and hard and heavy for the stone ax and wooden wedge.

The spruce and hemlock were splintery and hard to work and weathered badly. So a richness

Village Island, Alaska

Tongass, Alaska

edans, British Columbia

in timber lay untouched and useless till the white man came. If these had been the only trees, the people might have remained simple food gatherers.

But there was the cedar, the West Coast cypress, growing huge and plentiful in swampy areas around creeks and rivers. Oh, the cedar tree! If mankind in his infancy had prayed for the perfect substance for all material and esthetic needs, an indulgent God could have provided nothing better. Beautiful in itself, with a magnificent flared base tapering suddenly to a tall, straight trunk wrapped in reddish-brown bark, like a great coat of gentle fur, gracefully sweeping boughs, soft feathery fronds of gray-green needles.

Huge, some of these cedars, five hundred years of slow growth, towering from their massive bases. The wood is soft, but of a wonderful firmness and, in a good tree, so straight-grained it will split true and clean into forty-foot planks, four inches thick and three feet wide, with scarcely a knot. Across the grain it cuts clean and precise. It is light in weight and beautiful in color, reddish brown when new, silvery gray when old. It is permeated with natural oils that make it one of the longest-lasting of all woods, even in the damp of the Northwest Coast climate.

When steamed, it will bend without breaking. It will make houses and boats and boxes and cooking pots. Its bark will make mats, even

clothing. With a few bits of sharpened stone and antler, with some beaver teeth, and a lot of time—later on with a bit of iron—you can build from the cedar tree the exterior trappings of a great artistic culture.

Above all, you can build totem poles, and the people of the Northwest Coast built them in profusion: forests of sculptured columns between their houses and the sea, proudly announcing to all the heraldic past of those who dwelt there.

At most, there were probably no more than a hundred thousand people, scattered along a thousand miles of coastline—ten thousand miles more likely if bays and inlets and promontories and islands are measured. Isolated in clusters of a few hundred each, miles from their nearest neighbors, they were cut off by dense jungles, by stormy seas for most of the year, by five separate language groups and hundreds of distinct dialects, and by suspicions and animosities that often separated them more than the elements.

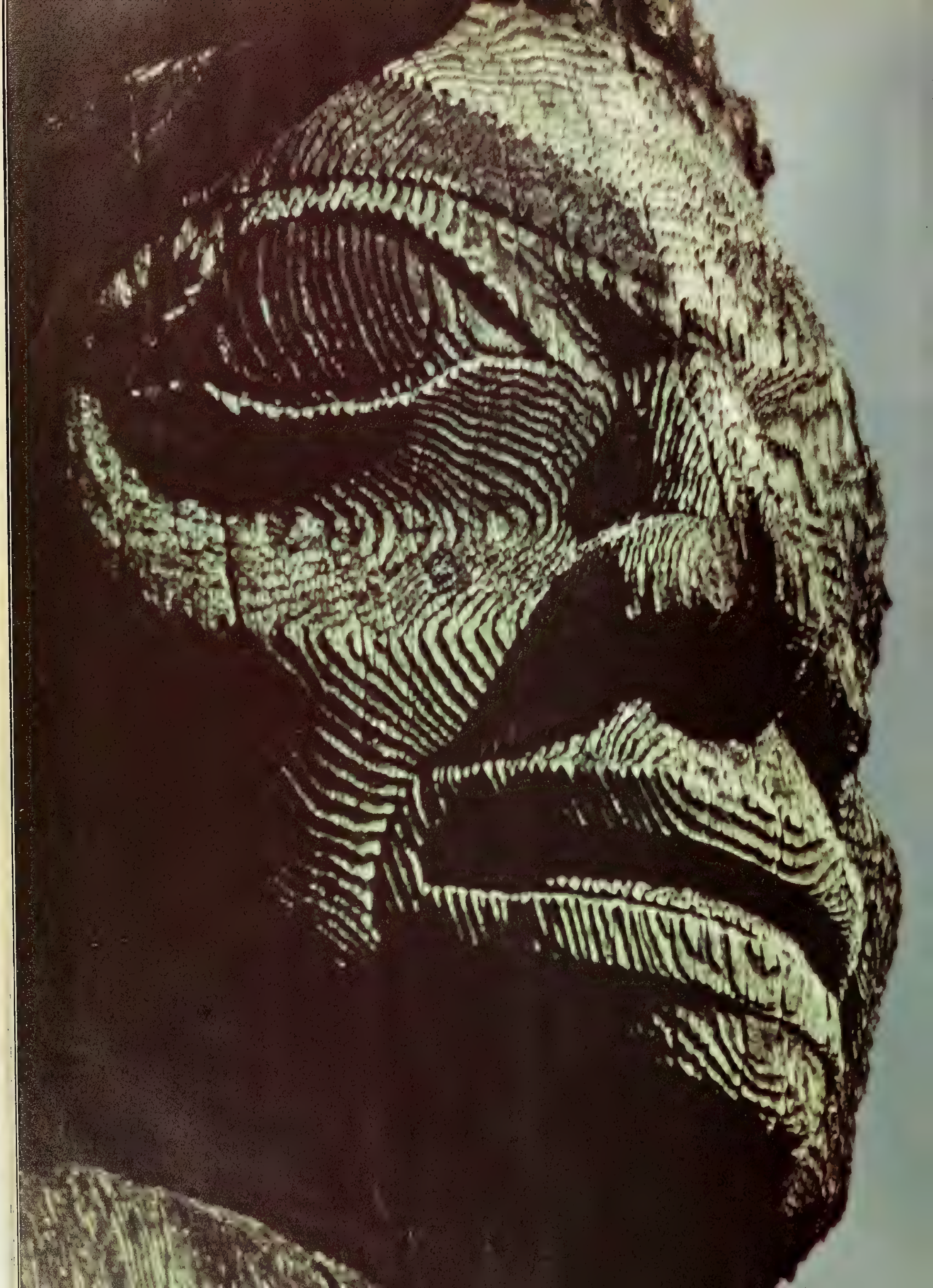
And yet, one of these clusters was Tanu. It

Old Kasaan, Alaska

Ninstints, Anthony Island, British Columbia

wasn't even a single political entity, but two villages separated by only a few yards. It knew no law beyond custom, no history beyond legend, no political unit larger than the family, no government beyond an informal meeting of family heads, plus the tacit acceptance of the superiority of the ranking chief. At the height of its influence, it had less than a thousand people living in about twenty-five houses.

But if the wooden structures of Tanu had survived the hundred years of north coast weather since the last of its survivors left, its ruins would rival man's greatest achievements. Tanu may have been the crowning gem of West Coast material culture. Some old memories still recall its artists and builders as the best, and old photographs show something of its glory. But it was only one of dozens of proud citadels—Kaisun, Kiusta, Squonquai, Skidegate, Massett, Kitwancool, Kispiox, Gitsixukla, Kitwanga, Kincolith, Kasaan, Klukwan, Bella Bella, Bella Coola, Koskimo, Quatsino, Nootka, and many more.



In each village were great houses some seventy feet by fifty feet of clear roof span, with gracefully fluted posts and beams. In the houses there were treasures that only great traditions and talent, and sometimes genius, with unlimited time and devotion, can create: thousands of masks, painted and carved chests, rattles, dishes, utensils of all kinds, ceremonial regalia. These were all carefully stored or proudly displayed during the great feasts and winter ceremonies. The people of the Northwest Coast centered their society around what was to them the essence of life; what we now call "art."

Old people can still tell "how it was" when, by boat, they rounded a point of land and entered a sheltered bay to find a village of large houses and totem poles facing the sea. Like heraldic crests, these poles told of the mythological beginnings of the great families at a time before time, when animals and mythic beasts and men lived as equals, and when the play of raven and eagle, bear and wolf, frog and beaver, thunderbird and whale established all that was to be.

The poles were many things. The house pole told of the lineage of the chief who presided within. The memorial pole commemorated some great event. The grave pole contained the body and displayed the crest of a leading noble. In many of the great houses, massive figures—illuminated by firelight—supported the roof beams. Each pole contained the essential spirit of the individual or family it commemorated, as well as the spirit of the artists who made it, and by extension, the living essence of the whole people. While the people lived, the poles lived, and long after their culture died, the poles continued to radiate a terrible vitality that only decay and destruction could end.

Even trapped in the stairwells of museums, truncated and dismembered in storage sheds, or lying in shattered fragments in now-vanished villages they once glorified, the contained power—born of magic origins and the genius of their creators—still survives.

These monuments were the work of master carvers and apprentices who brought to final perfection an art style whose origins lay deep in the past and partly in Asia. It was an austere, sophisticated art. Its prevailing mood was classical control, yet it characterized even the simplest objects of daily life. These seagoing hunters took the entire environment as art form.

That effort is now past. Even memory of it fades. Already the forest has reclaimed the tiny clearings men once maintained along the twisting walls of this stormy coast. Only a handful of poles now stand, others lie in the damp, lush forests. Like the fallen trees around them, they have become the lifeblood of younger trees growing from their trunks. In a scene subdued by a magnificent moss covering and by silence, they return to the forest that gave them birth.

itsalas Canyon, British Columbia

Man's Efficient Rush Toward Deadly Dullness

Diversity is more than the spice of life . . . it is an essential element of survival

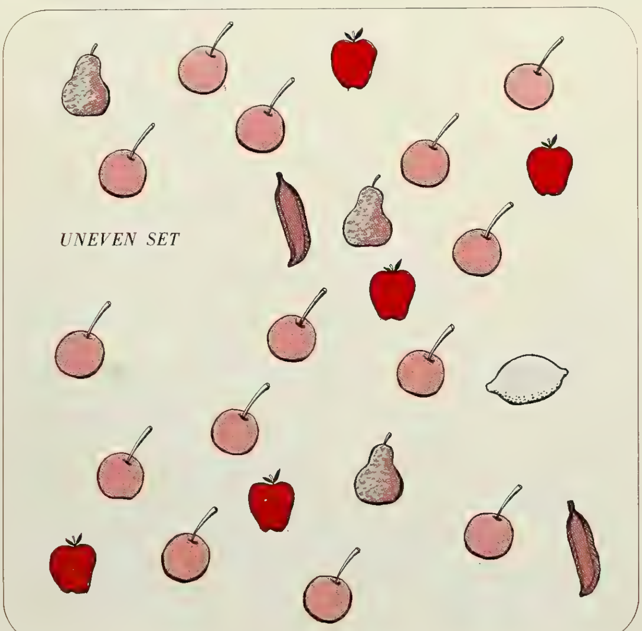
by Kenneth E. F. Watt

Is diversity of concern to people interested in natural history, conservation, and the environment? To answer the question fully, one must understand the exact meaning of diversity, the ubiquitous loss of diversity in the world today, and the reasons for the value of diversity.

An argument for preserving anything, particularly something rare, often turns out to be an argument in disguise for diversity. Thus, it seems worthwhile to provide natural historians with a handy kit of powerful arguments for variety because all too often they feel defenseless when confronted with the arguments of developers, which are clearly supported by short-term economic benefits, at least for a few investors.

The rapid loss of diversity in the world is a serious and pervasive phenomenon. Everywhere we look, we see examples of a large number of diverse entities being replaced by a small number of similar entities. We all know about endangered species such as birds of prey and large mammals, including all species of whales. Most of the world's commercial fish stocks are in danger, shell collectors are depleting tropical beaches and coral reefs, and pollution will annihilate commercial shellfish populations, resulting in simplification of our diets. But progressive environmental simplification is far more widespread than this. Half the butterfly species have disappeared in Holland in the last few decades. Conversion of the Russian steppe from wild plants to wheat fields has cut the number of

The Concept of Diversity



To understand the intrinsic value of diversity, we must be explicit as to what we mean by the concept. Diversity measures two characteristics of any set of items: *evenness* in numbers of different items in the set; and *richness* in numbers of different items within the set.

To illustrate evenness, suppose we have two different sets comprising 25 items of five types:

Uneven Set		Even Set	
Cherries	14	Cherries	6
Apples	5	Apples	5
Pears	3	Pears	5
Bananas	2	Bananas	5
Lemons	1	Lemons	4
Total	25	Total	25

Richness depends on the number of items as well as the variety of items in a set. In the following table, the relative abundance of the first four items is the same in each set, but the second set is richer because it has both more items and rare items.

Types	First Set	Second Set
A	4	12
B	3	9
C	2	6
D	1	3
E		2
F		1
G		1
H		1
Total	10	35

insect species there by 58 percent.

In the economic sphere, there has been a tremendous reduction in the number of manufacturers (think of the number of automobile manufacturers in the United States in 1910). Our numerous corner grocery stores have been replaced by a small number of huge supermarkets. In many fields, large numbers of small businesses have been replaced by small numbers of large businesses, to the point where we now have close to a monopoly in the manufacture of automobiles, aircraft, and computing equipment. Similarly, in agriculture large numbers of small farms have been replaced by small numbers of gigantic farm corporations.

Textural and cultural diversity has declined in our cities, whether you compare different parts of the same city or different cities in different countries. Driving from an airport to the downtown section of a city, the signs tend to be in the same language (English) and to advertise the same products, whether one is in Rome, Beirut, or Singapore. Stores and banks seem to be stamped from a common mold.

Remarkably, the same process has occurred in the human population. An extraordinarily high proportion of the world's population is now very young. The variety once found when many human age classes coexisted in approximately equal numbers has gone.

There are too many examples of the decline of diversity for this situation to have come about by chance. There is indeed an underlying explanation: we live in an age, and a culture, that puts tremendous emphasis on efficiency and productivity as desiderata for mankind. Since variety is inimical to these goals, variety has suffered and will continue to suffer. Unless powerful and compelling arguments can be offered to stop this loss of diversity, we will soon be living in a homogeneous—and boring—world.

The large number of specific arguments for maintaining the diversity of particular sets of plants, animals, or other items, all fall into four categories: (1) diversity promotes stability; (2) it insures against risks; (3) it utilizes more completely the sun's energy; and (4) it promotes the mental well-being of humans.

Stability

There are only two basic elements in all theoretical arguments as to why diversity promotes stability. The first is the idea of spreading the risk (the same idea applies when you buy insurance from the largest insurance company). If an organism feeds on many different species, the chances of all its food sources being wiped out in some catastrophe are less than if the organism feeds on a few, or only one, species. The second idea is that a system functions more harmoniously if it has more elements because it then has more homeostatic feedback loops.

This abstract language can be translated into concrete examples. The greater the variety of foods the

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In nature, an environment that is more tolerant of rarity has a larger number of species, or more richness.

Given that diversity measures both evenness and richness, can a single, simple measure combine both characteristics? In algebraic terms, we can arrive at such a measure, which will also give us a deeper understanding of diversity. Suppose we have N items in a set, divided into N_1 items of the first type, N_2 items of the second type, and so on, to N_n items of the *nth* and last type. Suppose N is 5, and we want to know the number of different ways we can arrange the five items in a row. The arrangement is $5 \times 4 \times 3 \times 2 \times 1$, which is typically written as $5!$ In general, the number of ways we can arrange N items in a row is $N!$ A measure of the ways in which we can arrange the items is given by

$$\frac{N!}{N_1!\,N_2!\,N_3!\ldots\ldots N_n!}$$

This can also be thought of as a measure of the variety, or diversity, within the set. By dividing the whole expression by N, we get a measure of the diversity per individual in the set. Using the first example of uneven and even sets, we get

$$\frac{1}{25}\left[\frac{25!}{14!\,5!\,3!\,2!\,1!}\right]$$

and

$$\frac{1}{25}\left[\frac{25!}{6!\,5!\,5!\,5!\,4!}\right]$$

The even set has 841 times more diversity per individual than the uneven set.

In the richness comparison, the diversity per individual is 15.6×10^{16} times greater in the richer set than in the less rich set. For those with an intuitive feeling for mathematics, this comparison will have great impact on their feelings about what mankind is doing to the planet by diminishing evenness and richness in the array of plants, animals, and everything else.

human population has available for harvesting, hunting, or fishing, the less the likelihood of human catastrophe due to a disaster befalling a particular food species. A most chilling example was the potato famine in Ireland, where an entire human population was excessively dependent on one food species. The situation is fundamentally the same when an Indian tribe depends greatly on salmon at a certain time of year, and then something happens to the salmon population (pollution or modification of the environment in the spawning stream due to a hydroelectric installation, for example). What few people realize is that the entire human population is now setting itself up for the same situation. For example, as we rapidly deplete the stocks of more and more oceanic species through overfishing and pollution, we cut off optional food sources that we might need desperately in the future. The larger the human population becomes and the more the sources of food decline, the more precarious is our situation.

Our great preoccupation with productivity and efficiency and our lack of concern about diversity increase the precariousness of our economic lives, as well as of our food. Consider what happens when we try to maximize the manufacturing efficiency of aircraft. We are led, inexorably, to a situation in which a small group of corporations manufacture all aircraft in the United States. Each corporation is so large that it dominates the economies of the communities in which its plants are located. Thus, if a corporation meets with disaster, the community is in deep trouble. This is the case in Seattle, where Boeing sales slackened with saturation of the international aircraft market. Architectural writer Jane Jacobs discovered this principle of relating the economic stability of cities to their corporate diversity when she applied current ecological theories about the relation between diversity and stability to her urban studies.

In a most curious way, diversity appears to affect our economic, social, cultural, and political processes. For example, a slowly growing or nongrowing human population has a greater evenness of numbers in different age classes than a rapidly growing population.

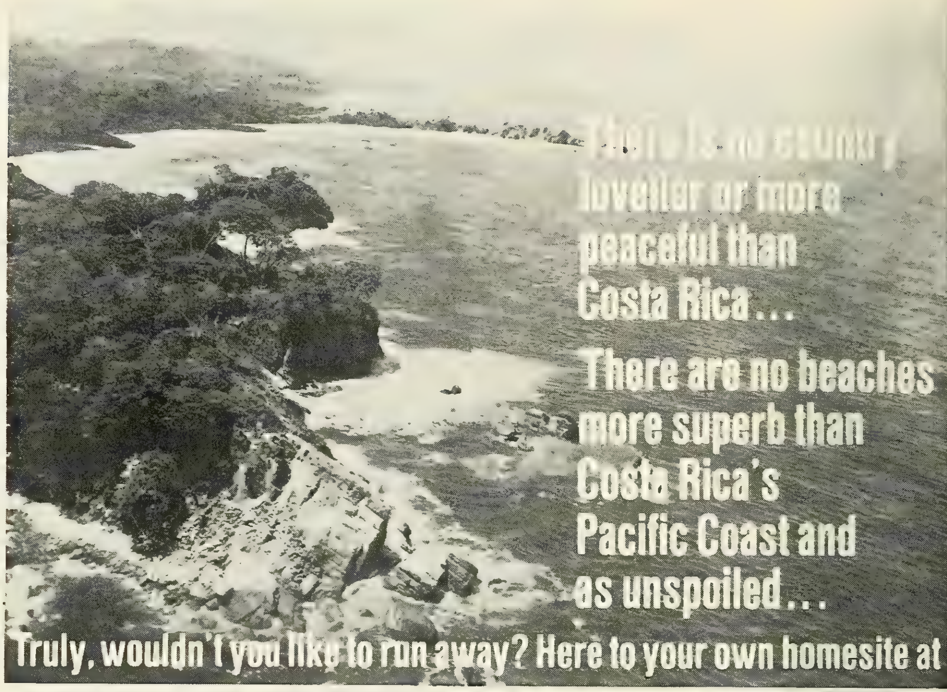
In a rapid-growth situation, young people are being added to the population so quickly that their numbers become unusually high relative to the numbers of older people. This strains society's ability to generate adequate educational taxes from the older group for the large younger group. It also is difficult for a rapidly growing society to create new jobs at the rate at which young people want to enter the labor force. This will be obvious as unemployment in the United States climbs above 6.0 percent of the prospective labor force when the next age class graduates high school and college in June, 1972.

The more even the numbers of people in different age classes, the easier it is to maintain good communication between generations. Thus, all the present discussion about a "generation gap" has its ultimate origin in the lack of diversity in human age classes.

Many similar arguments relating diversity and different forms of stability could be put forth. But the fundamental structure of all such arguments would be the same, whether the subject is a human society or a rare plant. The reason for preserving it is that it may, in some unknown fashion, be important to the maintenance of stability in a part of the planetary ecosystem.

Insurance Against Risk

The second class of arguments for maintaining diversity is similar to the argument for buying life insurance. You don't really want or expect to use it, but you buy it just in case. Similarly, a civilization does not expect its acts to harm the world, but just in case they are destructive it would be nice to have at hand other things to fall back on. For example, when we develop new strains of plants and animals, we do not plan on producing lines that will deteriorate in the future. We do not plan on producing strains of collie dogs in which the females will have progressively more difficulty bearing viable offspring, or strains of wheat that will succumb to rust, or berries that after many generations will no longer have much flavor. When these unintended events occur, we fall back on our "insurance policy," either by backcrossing our domestic strains to wild strains or by shifting our attention to new strains



BEACHES of NOSARA

Truly, wouldn't you like to run away here to this garden of ours? Doesn't your bruised spirit need the soft touch of loving people, your tense body the pure spray of clean, *clean* air filtered by sunshine? Don't you long for a place where every day is gentle summer, where tree-wrapped mountains stretch 12,500 feet to the sky, where tumbling streams and waterfalls and wave-lapped beaches beg to heal you?

In all truth, isn't it a sort of self-destruction to accept without demur (as maybe you do) the dank cheerless clutch of winter cold—the wintry faces of cheerless people?

So we ask you again: wouldn't *you* like to run away here to a place of your own in this nature-blessed country, inhabited by a people who deserve every bit of the beauty they've been given?

For the astonishing fact is that the Costa Rican people—perhaps like none other on earth—live in peace. All of them, each with the other, live and work in *PEACE!*

Consider them, the 1¾ million of them: handsome, gentle, literate, industrious and (phenomenon of our times!) kindly—a European-sprung people who are constantly embracing, shaking hands, even with strangers, a people to whom law and order is symbolized by a smiling policeman armed with nothing more menacing than a whistle, directing traffic with a murmured "*por favor.*" The phrase "law and order" doesn't have an ominous meaning here. It's incredible for a foreigner to learn that there is no army in Costa Rica (without an army, Costa Ricans say, there is no danger of a military take-over). The only military uniforms worn are by police and there are more schools in Costa Rica than there are uniforms. Not alone more *school-children* or more *school-teachers* but actually more *schools* than military uniforms! Amazing? No wonder that Gov. Nelson Rockefeller, having undergone a rather stormy Latin American tour in 1968, exclaimed happily when he finally got to *simpatico* Costa Rica: "This perfect jewel of a country!" *The NEW YORK TIMES* in an editorial on February 5th, 1970 headed *"Costa Rica's Example"* praises the solid democracy of this tiny country and says in part: *"Doing what comes naturally, a half-million voters have brought off (Costa Rica's fifth successive) peaceful presidential election in twenty years."*

Yet, it isn't only each other whom Costa Ricans like. There is no xenophobia here at all: foreigners are warmly welcomed and North Americans, especially, are cherished. Nearly 15,000 of us from the U.S. live and prosper in Costa Rica. English is widely spoken, and the word has been gradually slipping out that in this *"jewel of a country"* lies the fulfillment of the wistful dream of so many harassed Americans: the mind picture of that perfect retreat where climate and man are in gentle harmony with each other.

It's rather astonishing that this spectacularly beautiful country, really not that distant from the States, is much less familiar to Americans than the islands of the Caribbean. Almost everyone knows, and many have visited, the grouping of tropical Edens called the West Indies—their fabled greenness, the sparkling waters in which they are set. Yet Costa Rica's climate has all the balm of its island neighbors and is more exhilaratingly varied. The sea that stretches along the east coast of this slender strip of Central America *is* the Caribbean. Go west less than 150 miles and there is the Pacific: nowhere does this greatest of oceans wash more beautiful shores than Costa Rica's. Incongruously, some travel writers have called this country "The Switzerland of Central America"; still it is true that Costa Rica's mountains are as glorious in their tropical setting as the Alps in *their* ambience. And it is further a fact that these mountains aid in making the climate the delight it is. San Jose, the capital, is in the central plateau, 3500 feet above sea level, and about midway between the Caribbean and the Pacific. The city's climate is simply nothing less than perpetual Spring with the mean temperature steady at 70° every month of the year. But even at Pacific coast sea level — at our BEACHES OF NOSARA, for example — even here, the mean annual temperature is only 78 degrees accompanied by humidity so low that it can't be matched by the Caribbean islands. And not to put down the exotic West Indies, there's a good deal more of Costa Rica that the islands can't match. Nature thrives on an immense scale here. Naturalists have identified 762 species of birds (in *all* of the United States, 130 times Costa Rica's size, there are 725 varieties). And such birds! Partridge, parrots, cuckoos, toucans along with the wrens,

or species. But what if there are no new strains or species to replace the unsatisfactory ones?

The insurance value of diversity applies to more than just individual species or strains of plants and animals. Suppose a civilization irrigated farmland in such a fashion that long-term, irreversible destruction of the soil only showed up after a century. Suppose, further, that the entire landscape of this civilization had been managed in an identical fashion. Then when the entire landscape lost its fertility, the civilization would be without land to produce food. Further, it wouldn't even have any unmanaged land to compare with the managed lands for scientific investigations. A simple example of the importance of such comparisons is the few forest areas in Greece from which goats have been excluded. The contrast between the grazed and ungrazed lands is so startling that no argument from goat-lovers could withstand visual comparison of forested areas with and without goats.

It is tremendously important for any civilization to set aside areas where common cultivation practices are not adopted. If the same techniques are used everywhere, we can never know the long-term results of the practice. Thus, we can never know if intensive annual pesticide sprayings have long-term deleterious effects on orchards, forests, or woodlots unless we have unsprayed areas for comparison.

In short, a prudent civilization maintains the landscape under many different management strategies, including parcels of each soil and climate zone that are not managed at all. This landscape diversity has two values. First, we have a yardstick for determining if something unexpected or odd is gradually showing up in a managed area. Without the unmanaged areas, the odd or unexpected effect could be ascribed to something else, to a change in climate, for example. The unsettled arguments as to whether the changes in the landscape of the Mediterranean basin, the Middle East, North Africa, and northern India were due to climatic change or man's activities show clearly the importance of having unmanaged areas for checking. The second value of landscape diversity is that if a civilization unwittingly destroys

its managed lands, it has other places on which to raise food while the destroyed areas are gradually rebuilt to productivity.

A generalization of this argument holds that an extremely prudent civilization would try to maintain other civilizations with different ideas about land use. Over the short term, the ideas of civilization *A* might appear vastly superior to those of civilization *B*. But over the long term it could turn out that the apparently "primitive" practices of civilization *B* were based on millennia of trial and error and incorporated deep wisdom that was unintelligible to civilization *A*.

Fuller Use of Energy

The third argument for diversity originates in the theory of modern ecologists that any habitat contains a set of "niches," or functions, that may be filled. If only part of the niches are filled, then the sun's energy that is captured by, and flows through, a system will be less than if all the niches were filled.

Perhaps the best known and most convincing illustration of this argument comes from Africa. Research shows that a mix of native animal species uses the landscape more economically than imported livestock. Each of the different types of antelope and other game consume slightly different mixes of food plants or parts of plants, so that a whole assemblage of different species uses the landscape more efficiently than, say, beef cattle would by themselves.

The same point has been demonstrated repeatedly in analyses of the fish production per year per acre from different mixes of fish species. The more fish species there are in a body of water, the greater the gross production. Human understanding of this principle reaches its pinnacle in Oriental fish farming, where up to nine different species of carp are grown together in the set of proportions that makes best use of the resources in a pond.

Mental Well-being

Humanity has given far too little thought to the fourth argument for preserving diversity. How much diversity in the world around us is optimal for the human mind? Might the extent of environmental diversity have any relationship to the average level of mental health in a population? Could a certain level of diversity be most satisfying—emotionally and esthetically—to the human mind because of the conditions during human evolution? Diversity in an environment may have a much deeper significance for man than is generally recognized. We know that human beings tend to hallucinate when kept in confined quarters and deprived of sensory stimuli. This could be interpreted as a protective device by the mind to provide an otherwise unavailable need. Reports have been published indicating that extremely refractory mental patients, who had not spoken to anyone in years, showed an almost miraculous response when taken to wilderness areas.

The recent popularity of skin diving as recreation may convey a deep message. It may be that the rate of incoming sensory stimuli while skin diving is optimal for the human mind. I know that after several hours of constant interruption by the phone and visitors, I almost jump with each new phone call. But I also know that I can become bored amid all this stimuli. The extremely deep satisfaction I derive from exploring the ocean edge of a tropical island may be telling me something important about my mind and all our minds. We have evolved over a very long period so that our minds can cope handily with a certain rate of incoming sensory stimuli. We find the stimuli rate we can cope with in nature because we evolved there. Either sharply higher or sharply lower rates of incoming sensory stimuli are bad for our nervous systems.

This is only anecdotal evidence, but more carefully designed and measured research leads to the same conclusion. For some years, Prof. J. Lee Kavanau of UCLA has been conducting experiments on small mammal behavior in heavily instrumented cages. These cages are wired, enabling the animal to change its environment and recording every move the animal makes and every detail of the conditions in the cage. The animals learn to control their environment by pressing levers. Kavanau has discovered that animals will press levers to select other than optimal conditions. In other words, confronted with a choice of living constantly in an optimal world but being bored, or of living in a world that is only optimal part of the time and experiencing variety, even a small rodent will opt for variety. It is reasonable to assume that humans would opt even more strongly for variety rather than constant optimality. Perhaps diversity is not merely a luxury for us. It may be something we need.

If, upon reflection, you agree with my general line of argument as to the intrinsic value of diversity, then important implications follow for many aspects of our lives. Particularly, the argument has important political implications.

For example, if diversity breeds stability, then it is worthwhile for a government to regulate the rate at which different interest groups acquire wealth and power. Undue concentration of power and wealth allows a small group of people to change the landscape to suit themselves, even though the change may not suit others. For example, wilderness mountaintops and tropical islands have been overdeveloped for second homes because the prospective profits for developers were very large relative to the total costs for society. Costs were small for the developers because they were not equitably divided within the society. If something went sour with the development—the lots didn't sell after trees were bulldozed—or if subsequent sewage and pollution control costs spiraled, then someone else, not the developer, absorbed the costs. Thus, the developer reaped a great gain from subdividing, and someone else paid the price. Given this situation it is scarcely surprising that so much of the world is being destroyed or that diversity is diminishing so rapidly.

A comparable situation exists with respect to the oceans, which our culture treats as an international "common property resource." Since no one or no one nation owns the oceans or their contents, no one has a motive for perpetuating the living diversity of the oceans. Consequently, the precious living treasures of two-thirds of the earth may be less diverse or even depleted in a short time. And there are too many links between oceanic and terrestrial life for such a loss to occur without profoundly affecting humanity. ■

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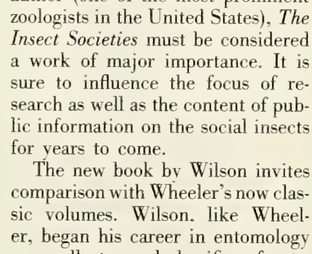
The Social Insects

by Mary Jane West Eberhard

THE INSECT SOCIETIES, by Edward O. Wilson. *Belknap Press of Harvard University Press, $20.00; 548 pp., illus.*

Evidently we are to witness the publication of a really major English-language treatise on the social insects only once every fifty years. In the present century the first was William Morton Wheeler's 1923 book *Social Life among the Insects* (complemented in 1928 by *The Social Insects*); the second is Edward O. Wilson's *The Insect Societies*. If only because of the rarity of the event and the stature of the author (one of the most prominent zoologists in the United States), *The Insect Societies* must be considered a work of major importance. It is sure to influence the focus of research as well as the content of public information on the social insects for years to come.

The new book by Wilson invites comparison with Wheeler's now classic volumes. Wilson, like Wheeler, began his career in entomology as a collector and classifier of ants, then went on to become interested in behavior, ecology, and sociality in general. Both works are written with impeccable clarity, agreeable style, and a sprinkling of Greek-flavored words such as *phthisogynes* (Wheeler's) and *ergonomics* (Wilson's). Wilson's book, like Wheeler's in its day, attempts to summarize and synthesize contemporary knowledge of the social insects. In 1923 this was an admirable accomplishment; today it is a truly gargantuan feat. By Wilson's reckoning, there are more than 12,000 articles in the scientific literature on ants alone, embracing such diverse sciences as systematics, ecology, behavior, and biochemistry. Wilson, who has made original contributions in all these fields, is one of the few people in the world both learned enough to write a modern, comprehensive book on the social insects and daring enough to undertake it singlehandedly.



Bald-faced hornet

The Insect Societies would be a good present for a curious and intelligent older child, an imaginative biology teacher, a serious armchair naturalist who likes insects, or a specialist in one kind of social insect who wants to read up on the others. Its 22 chapters cover virtually every important topic in the study of social insects, including communication, senses and intellectual capacities, population dynamics, and theoretical considerations. The first four chapters outline the natural history of each of the four major groups of social insects: the social wasps, the ants, the social bees, and the termites. Rather than summarizing all of the information available on all species, which would result in a dizzying hodgepodge of facts, Wilson has described in some detail the life-styles of selected, relatively well-known examples: yellow jackets, honeybees, tropical stingless bees, army ants, and fungus-growing termites, to mention just a few. A rather sketchy treatment of the social wasps, due partly to the sparse nature of the information available on them, is compensated for by a magnificent chapter on the ants—not only Wilson's speciality but as a group probably the best known of all social insects. Caste determination, the still mysterious process by which some individuals become sterile workers and others become reproducing kings or queens, is discussed in separate chapters; and there are bonus chapters on the presocial insects and the symbionts, or companions (helpful, harmful, and neutral), of social species, where one can glimpse such exotic scenes as a mother tingid bug giving an antennal rebuke to her straggling offspring, and a staphylinid beetle duping a worker ant into giving it a free meal.

The much discussed "genetic theory of social behavior" developed by the English biologist William D. Hamilton is given the ample consideration it deserves. This is a theory that at last provides scientific justification for the age-old tendency to compare insect and human societies, suggesting common elements in social evolution throughout the animal kingdom. As such, it should influence the views of sociality held by anthropologists and psychologists as well as zoologists; yet it has so far been discussed almost exclusively by insect sociologists and theoretical biologists. This is the first detailed presentation of it in a widely accessible book. The implications of the theory are presented as a series of "predictions" and "evidence" that may make them difficult for the uninitiated reader to grasp. While eminently thorough, this method forces one to evaluate the theory piece by piece before having a clear picture of it as a whole, and the emphasis on problems of the theory leaves the impression that the whole thing is somehow very much in doubt. Actually the central point—the importance of degree of relatedness of interacting individuals in the evolution of social behavior—is irrefutable if one accepts the basic tenets of evolutionary theory.

While much of the book was clearly written with professional biologists in mind, it will undoubt-

Colony of honeybees

edly become the standard reference volume for anyone with a question to ask about social insects. People for whom "dichthadiiform ergatogyne" is not a household word will be aided by a multitude of illustrations, an extensive index, and a glossary. The glossary includes both technical terms and ordinary words (like "commune" and "elite") used in special ways, but it has some curious omissions. Some readers may be left thinking that a "monotonic function" is a songfest for the untalented. Also helpful are the unfailing clarity of the writing and the felicitous choice of colorful quotes and examples, such as the story of a European-style garden in Central America being carried away, bit by tender bit, by the "wiwi-laca," the formidable leaf-cutting ants of the American tropics. Some of the more technical sections, such as the detailed discussion of allometry (the developmental basis of certain caste differences) can be skipped over by the average reader with little loss in understanding. For readers interested in fine points, such sections will prove invaluable syntheses. The discussion of caste determination in honeybees, technically one of the more complicated in the book, is also one of the most readable. It is both intrinsically interesting and particularly well written, although lovers of the old, romantic, anthropomorphic style will be both shocked and disappointed to find that for Wilson the honeybee is "just one more eusocial apoid."

The illustrations deserve special mention. Wilson has used exceptional taste and care in choosing from among the best published drawings and photographs of social insect behavior and natural history, adding some unpublished ones supplied by colleagues and two excellent commissioned artists. The frontispiece is a beautiful full-page color reproduction of Frank M. Carpenter's spectacular photograph of a fossil ant, and many of the text illustrations occupy all or half of the 8- by 10-inch pages.

A major intent of the book is "the expression of insect sociology as population biology." In keeping with this theme there is a valuable chapter on the population dynamics of colonies, the first real synthetic treatment of this subject. The author makes an ambitious and affectionate attempt to move the study of social insects out of the plodding, grass-stained realm of the old-fashioned naturalists (who have provided most of the information in the book's 548 pages) into the IBM-fast, lab-coat-clean world of the "modern" biologists. "The evolution of social insects," says chapter 18, "offers an interesting array of the kinds of questions that can *only* [italics mine] be solved by the modern methods of population biology." Given as an example of modern methods is "optimization theory," which inspired Wilson's own mathematical model of the "ergonomics" of caste. Yet questions such as, Why do some species exchange regurgitated materials and others not?—cited as particularly subject to solution by these methods—are certainly just the kinds of questions that can "only" be answered with a great deal of field observation and comparative natural history of the traditional kind. The indispensability of mathematical models is still a moot point. But the Wilsonian approach may serve to

stimulate new generalizations and to attract to this important and interesting field people for whom simpler pleasures—such as the sight of a food-laden worker wasp feverishly "dancing" before her queen—are not attraction enough.

In writing this book Wilson has had to confront many controversies and resolve many points left fuzzy by previous writers. In a scholarly synthesis of this kind, specialists will find issues to debate and nits to pick. For example: Do the similarities between the separately evolved societies of termites and Hymenoptera (wasps, ants, and bees) really mean, as Wilson suggests, that "there are constraints on the machinery of the insect brain" that limit the kinds and degrees of their social organization, and that the ultimate social limits were reached 50 and 100 million years ago? The questionable implication is that these insects are no longer capable of major neurobehavioral evolution. Similar, heartily debated statements are sometimes made about the evolutionary progress of man. In three chapters on caste determination there is no mention of a haunting uncertainty as to how the many experiments on structural castes relate to the determination of functional (behavioral) differences—the most interesting aspect as far as social organization is concerned. And some will find it ironic that this "modern synthesis of insect sociology" has adopted a now artificial classification of degrees of sociality, using overlap of generations to distinguish between "presocial" and "eusocial" (truly social) behavior instead of emphasizing the reproductive division of labor now considered a far more important evolutionary event.

The final chapter, "The Prospect for a Unified Sociobiology," contains some of the most important thoughts in the book, ideas—such as an appreciation of the functional similarities between insect and vertebrate societies—that merit more than the three pages devoted to them. But it would be a bit silly to insist that the book go on to do even more than it does. For anyone, layman or specialist, interested in a single, concise, lucid, and authoritative account of the most significant facts and theories about insect societies, *The Insect Societies* is the

best available and will be for many years.

Mary Jane West Eberhard is a research associate in the Departamento de Biología, Universidad del Valle, Cali, Colombia. She is coauthor (with Howard E. Evans) of the book The Wasps.

WHO OWNS AMERICA? by Walter J. Hickel. *Prentice-Hall, Inc., $6.95; 328 pp.*

If for nothing else, dynamic, gusty Wally Hickel will go down in history as having been the first Interior Secretary in the "era of environmental awareness," which dawned with the Santa Barbara oil blowout in January, 1969, just as he was beginning his brusquely terminated, 22-month tenure. Originally suspected of being an exploitationist at heart, Hickel pleasantly surprised nearly everybody by his enlightened handling of a strenuous succession of environmental crises and issues, stretching from Alaska to the Everglades.

His initial, somewhat jumbled stab at memoirs—put together with the help of a half-dozen assistants, but refreshingly Hickelian in language—is more a political document than an environmental one. He makes a ringing pitch for genuinely populistic management of our natural resource heritage. But he's more concerned with detailing his falling-out with the Nixon administration and intimating his ready, willing, and ableness for future public office.

It develops that his celebrated letter to the president about listening to youth was only the last straw in a succession of hassles that got him crosswise with the Haldeman-Erlichman-Whitaker-Kissinger-Klein axis—and with Mr. Nixon himself.

He publicly touted low interest rates when that wasn't the cabinet line. He opposed clustering pollution controls under the Environmental Protection Agency umbrella. His sewage plant financing plan was mysteriously scuttled. Worst of all, events put him in the uncomfortable position of having been right on some key issues on which other administration people were wrong. He favored halting the Florida canal boondoggle long before the courts and the White House acted. His adverse memorandum on the SST was censored by the White House for public consumption. He assessed the 1970 Earth Day movement as a historic popular cause—and he alone in the administration committed his department to its support—when the White House was scared even to take cognizance of it.

But Mr. Hickel's accounting poses many questions about the depth in which he is willing to deal with environmental realities. He deplores the Santa Barbara oil mess without discerning, or at least acknowledging, that it was rooted in the piratical, nineteenth-century "grab it where you can" resource policy the oil industry has foisted on the public. He mentions the na-

tional land-use problem without going any further than to say we should take an inventory. (No use alienating the real estate industry and states' rights fanatics so early in the game.) He talks about the federal land-acquisition problem without mentioning the Land and Water Conservation Fund. He devotes more space to the question of how to save whales than how to save his adopted state of Alaska. He devotes eight paragraphs to his youthful pugilistic prowess, but only four paragraphs each to water pollution, timber problems, and strip mining, and only one paragraph to the multibillion dollar issue of federal shale-oil lands.

In many ways, Mr. Hickel performed superbly during a turbulent interlude in the evolution of a more enlightened national approach to resources. He owes the public, and his own reputation, a more thorough accounting of his travail and his views than this obviously hastily pasted together (and, incredibly, indexless) compilation— even as perhaps the electorate owes him, and itself, a less abbreviated demonstration of his indisputable talent for decisive action in public affairs. Hopefully both items may be forthcoming in some early go-around.

GLADWIN HILL
The New York Times

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18-19—Dental Radiography and Photography/Eastman Kodak
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32—AMNH
33—Harvey Price, Nancy Palmer Agency
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35-37—Harvey Price, Nancy Palmer Agency
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50—Lick Observatory
53—Hale Observatories
54-55—Helmut Wimmer
57-63—William J. Weber; except 61-AMNH
65-72—Adelaide de Menil
73—AMNH after de Menil
74-75—David Lindroth
86-87—Courtesy of Belknap Press/Harvard University

The Poppies Are Beautiful This Year

Continued from page 36

in a banana leaf or rice paper and either taken home or hidden in the jungle.

Many passes are made through each field because different plants will be ready at different times and each plant may be tapped several times. A large capsule, say 4½ inches in diameter, may receive as many as thirty-two incisions, representing six or seven passes, before it is considered worthless. After the harvest, the dried pods are collected and seeds kept for the next season. These seeds are also eaten as a snack, and the capsules are made into baby rattles.

Rice fields cultivated in this slash-and-burn manner can be used only two or three years in succession before yields decline sharply, but an opium-maize field can be used ten or more years. Yet, inevitably after such extended use, secondary jungle rarely grows back, and often only *Imperata* grasses grow. Thus, for many years to come, these fields are rendered insufficiently fertile for successful agriculture.

The primary resource that a Lisu can manipulate to increase his agricultural yield is labor. One way to increase the household labor pool is to have many children. Also, Lisu marriage involves both a substantial bride payment and a period of bride service during which a father-in-law may call upon his son-in-law for labor. The bride payment and the length of service are subject to negotiation before and after the marriage. Ambitious Lisu try to arrange for both their sons and sons-in-law to live close by in the same village so they will be available to work in the fields. Less closely related or even unrelated households may join these informal groups for economic cooperation and mutual support in disputes.

To further increase the labor pool, the Lisu hire Karen and Yuan opium addicts. While they are usually trusted only with routine or menial tasks, such as gathering firewood, clearing a field, or husking rice, their labor contribution is significant, and it is doubtful they would work for wages other than opium. Incidentally, compared to some of their neighbors, not many

Lisu have become addicted. Those who have are mostly elders, who make little economic contribution in any case.

Opium is a great democratizer. Since there is a ready market for it, any household with a sufficient labor pool may attain economic independence. Economic individualism is carried over into social and political life, and there are no distinct social classes. Each Lisu village, furthermore, is an independent political unit with only superficial ties to the Thai administration.

Opium is also important in Lisu religious life. There are more rituals associated with opium than with any other crop. It is used for offerings to some spirits. It is also practically their only effective medicine. Since the Lisu have lived in northern Thailand for a short period, they do not have an extensive pharmacopoeia. They remember the names of plants used in the past, but many of these are not found locally. The opium is smoked or eaten to counteract malarial fevers, and applied externally to the forehead for headaches.

While opium has thus made important contributions to Lisu society and provided a convenient and profitable product for the Lisu to base a livelihood on, it has also forced them to be dependent on the vagaries of an economic system they are not well equipped to deal with. They depend upon the lowlands for the necessities of life. They are at the mercy of middlemen who buy their opium, valley peasants who supply them with rice, and a lowland-based political administration with the power to cut off their primary source of cash.

With a clandestine and uncertain market for opium, the Lisu are unable to seek better prices in lowland towns because they are subject to search by the police. They must bargain in a foreign language with foreign middlemen who make huge profits, a situation that leads more often than not to antagonistic commercial dealings, rather than stable patron-client relations. Although they are economically dependent upon the lowlands, the Lisu are attempting to retain their political independence and keep the lowlanders from interfering in their daily affairs.

The potential for interethnic conflict is constant. In 1968 at Evil Peaks, many Lisu fields had been in use for more than ten years and their yields were declining sharply. There was, however, no suitable land on which to clear new fields. Over the years, Evil Peaks had been hemmed in on three sides by Karen villages and Yuan tea tracts (the tea is sold as *miang*, pickled tea leaves that are chewed as a snack). On the fourth side, the land had been declared a national forest reserve, and the Lisu had been warned by Thai officials not to clear fields there. While the Lisu felt that encroaching neighbors and reserves for which they could see no purpose (timber is not extracted at these altitudes) were depriving them of land on which to make a living, the neighboring Karen and Yuan looked upon the Lisu as irresponsible and aggressive newcomers, who devastated the land with their methods of shifting cultivation.

This situation was aggravated because the Lisu were generally economically better off than their rural neighbors. There were constant thefts of Lisu crops, pigs, and chickens. The Lisu had been forced to abandon cattle raising because of numerous rustlings. Lisu fields were set on fire prematurely, making them unusable. Yuan or Chinese bandits further inflamed this situation, and there were frequent incidents of violence, including several killings. When a Lisu youth was murdered in 1969, it was the unanimous opinion in Evil Peaks that the act had been committed by Yuan or Shan despite the police claim that it had been done by highland Lahu.

When the Lisu did occasionally look to lowland officials to redress their grievances, they seldom found satisfaction. Even when a Yuan was jailed for stealing a Lisu pig, the Lisu were not satisfied since they received no remuneration. The Lisu have an imperfect knowledge of lowland laws, language, and customs, and are seldom willing to pay either fees or bribes. They are aware of not being full citizens, for although they vote and pay taxes, they are not legal landowners. They are not drafted into the army, and because of their isolation and cultural differences, they do not benefit from most government services.

Rather than contest the rights

over the land around Evil Peaks or put up with constant thievery and harassment, in 1969 and 1970 three-quarters of the inhabitants emigrated to other Lisu villages. In fact, migration is the usual Lisu reaction to threats of large-scale conflict. A change in ethnic identity may be another reaction. Nevertheless, the Lisu realize that they cannot continue to find new lands. The population in the highlands of Thailand is growing, the result of natural causes as well as of immigration from neighboring countries and the lowlands. And recently, savannas, on which shifting agriculture is not possible, have become more widespread. Many Lisu asked me where they could go in thirty or forty years, after the present land is used up.

Both lowlanders and national governments are increasingly aware of highland people such as the Lisu. Highlanders are blamed for deforestation and the resultant erosion and flooding of the lowlands. Fears of insurrections, such as that of the "Red Meo" near the Thai-Lao border or the "Red Karen" near the Thai-Burma border, are growing. The Thai government, having declared the trade and use of opium illegal, can confiscate it whenever they find it.

New interest in the highlands has resulted in a multiplicity of programs designed to promote change. The government, army, police, Buddhist and Christian missionaries, and even volunteer lowlanders have introduced educational and medical services to the Lisu and other highland villagers in the past decade. New cash crops, such as coffee and peaches, have been promoted to replace opium. Resettlement in the lowlands or in designated highland areas has been encouraged to stabilize residence and facilitate administration.

Unfortunately, the speed with which these programs have been initiated has resulted in a lack of coordination and little understanding of the significance of some of the proposed changes. At one Lisu village with eleven homes, two different medical programs were being carried on, while another village with 150 or so houses had never seen a doctor.

The effectiveness of these programs depends heavily on the indi-

viduals and officials actually in contact with the peope, and while many of them are well meaning and capable, the general lack of knowledge about each other's cultures will continue to be a major hindrance. The king of Thailand, who has taken an interest in the problems of the country's highland minorities, has suggested the need for a changed attitude on the part of some officials. (On November 17, 1971, a group of military and other leaders in Thailand seized power, purportedly to "protect the king and the people" from Communist insurrection in the north and other internal strife, as well as from "a threatening world situation." What effect, if any, this will have on the opium trade is speculative.)

The effort to replace opium in the economy of many highland villages will be particularly difficult. The prospects of ever finding a substitute crop as well adapted to the local environment and market conditions are dim. One of Thailand's most influential journalists, Kukrit Pramoj, has proposed that highlanders be allowed to continue growing opium poppies and that the government buy up the crop. But whenever it has been suggested that opium growing be prohibited by force or when other threats to the opium trade have arisen, serious incidents have occurred. For instance, in 1970 the building of a highland road in Tak Province was halted when the construction workers were attacked by Meo who, it is said, feared the road would mean an end to their opium growing.

And yet, change is nothing new to the Lisu. They have lived in many states and have had many neighbors with whom they have exchanged many goods and ideas. In Yunnan, the changes undergone by the Lisu under Communism seem even more drastic than those faced by the Thailand Lisu. In China, they have been organized into cooperatives and communes to practice irrigated rice farming, and they have developed some small-scale industry. Several have acquired university educations. But for the Lisu and the other villagers of Thailand's mountains, the future seems to loom ominously and the need for change seems irreversible. With an economy based on opium, their problems are rife. ■

Suggested Additional Reading

THE FASHIONABLE TOOTH

A History of Dentistry from the Most Ancient Times to the Eighteenth Century. V. Guerini. Milford House, Kennebunkport.

Yiwara: Foragers of the Australian Desert. R. Gould. Charles Scribner's Sons, New York, 1969.

Ritual Ablation of Front Teeth in Siberia and America. A. Hrdlicka. Smithsonian Miscellaneous Collections, Vol. 99, No. 3, 1940.

HOW THE MIDWEST WAS WON

Wilderness for Sale. W. Havighurst. Hastings House, Inc., New York, 1956.

The Cuyahoga. W. D. Ellis. Holt, Rinehart & Winston, Inc., New York, 1967.

Delineations of American Scenery and Character. J. J. Audubon. Arno Press, Inc., New York, 1970.

THE POPPIES ARE BEAUTIFUL THIS YEAR

Political Systems of Highland Burma. E. R. Leach. Beacon Press, Boston, 1965.

Ethnic Groups of Mainland Southeast Asia. F. M. LeBar et al. Human Relations Area Files Press, New Haven, 1963.

Logistics of Junk. D. Lyle. *Esquire,* March, 1966.

THE SOCIAL CARNIVORE

Simba. C. A. W. Guggisberg. Bailey Brothers & Swinfen, London, 1962.

Animal Dispersion in Relation to Social Behavior. V. C. Wynne-Edwards. Hafner Publishing Company, Inc., Darien, 1962.

The Cats of Africa. M. Edey, ed. Time-Life Books, New York, 1968.

A NEW WORLD FOR THE CATTLE EGRET

Breeding Behavior of the Cattle Egret in Colombia. D. A. Lancaster. *The Living Bird,* 9th Annual Edition, 1970, pp. 167-194.

Ornithology in Laboratory and Field. O. S. Pettingill, Jr. Burgess Publishing Co., Minneapolis, 1970.

The Cattle Egret. M. Fogarty. *Florida Wildlife,* April, 1971.

OUT OF THE SILENCE

Northwest Coast Indian Art. B. Holm. University of Washington Press, Seattle, 1970.

Art of the Northwest Coast Indians. R. B. Inverarity. University of California Press, Berkeley, 1967.

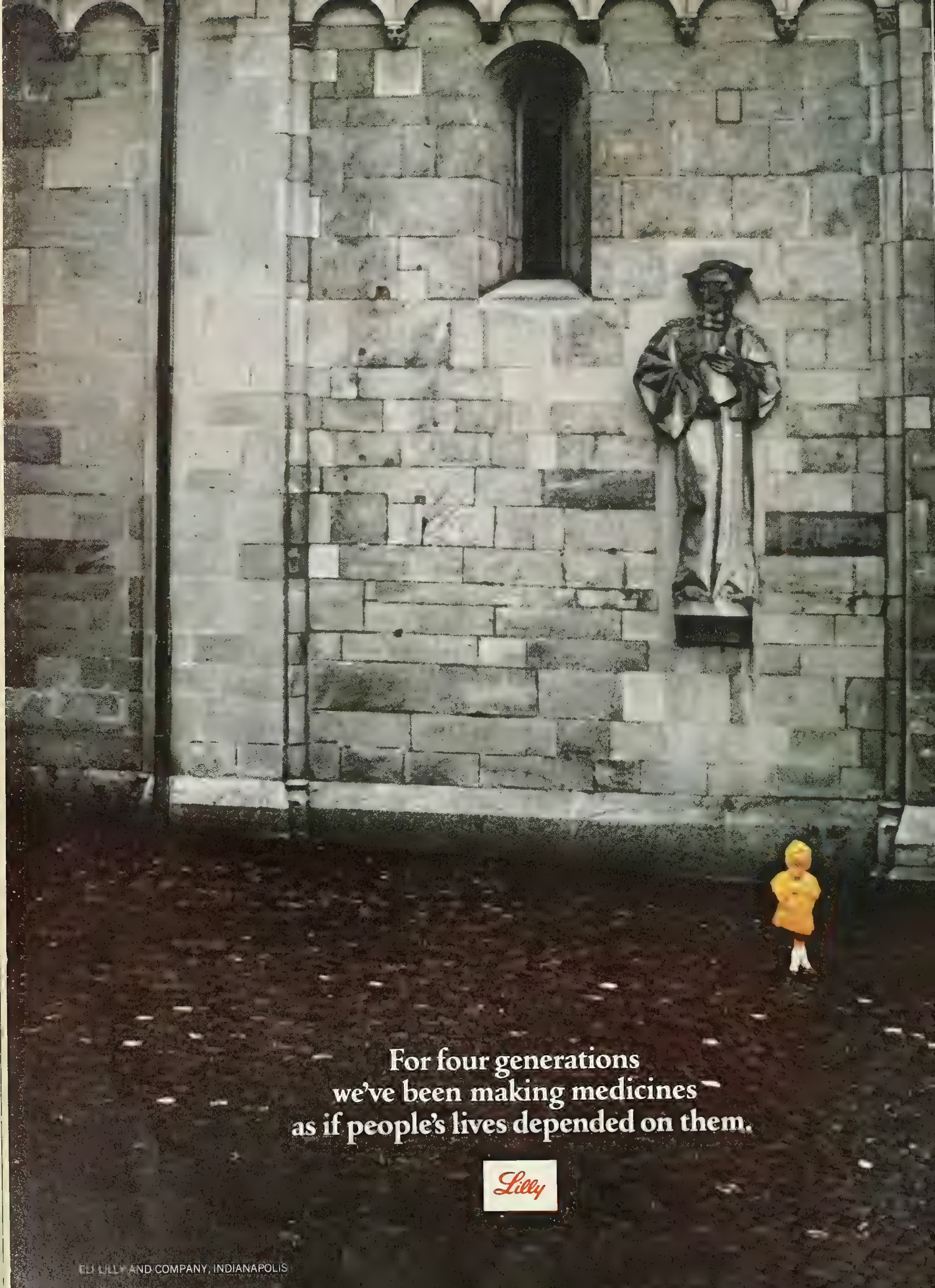
Indians of the Northwest Coast. P. Drucker. The Natural History Press, Garden City, 1963.

MAN'S EFFICIENT RUSH TOWARD DEADLY DULLNESS

The Technological Society. J. Ellul. Alfred A. Knopf, Inc., New York, 1964.

The Economy of Cities. J. Jacobs. Random House, New York, 1970.

Perspectives in Ecological Theory. R. Margalef. University of Chicago Press, Chicago, 1968.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The American Museum of Natural History

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Vol. LXXXI, No. 3   March 1972

COVER: *This sifaka, a graceful animal, appeared in one of Alfred Grandidier's volumes on the lemurs of Madagascar. Its tail, curled like a watch spring, is actually a balancing organ.*

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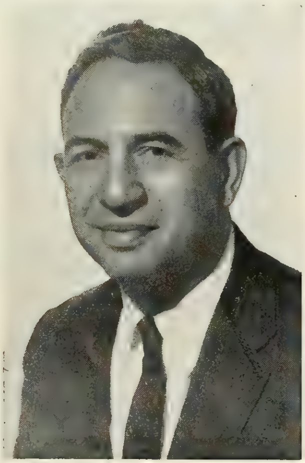
Authors

E. Raymond Hall, author of "Down on the Farm," manages a 107-acre farm in Marysville Township, Kansas, where he raises soybeans, milo, corn, and wheat. Before retiring to the farm, Hall led a busy life indeed. After receiving a Ph.D. in zoology from the University of California at Berkeley, he was the chairman of the Department of Zoology of the University of Kansas, director of the University of Kansas Museum of Natural History, a vice-president of the American Association for the Advancement of Science, and a consultant on communications to American Telephone & Telegraph—to mention only a few of his accomplishments.

Two new columnists make their debut in this issue. The first is **Arthur W. Galston**, professor of botany at Yale University. Galston gained considerable attention last spring when he and a colleague became the first American scientists in more than twenty years to visit the People's Republic of China. Some of the aspects of this trip will be the subject of forthcoming columns, and more material will come from a three-month visit to China planned for this summer. With his wife and daughter, he will live on an agricultural commune, spending half his time at a research institution. While commenting on Chinese practices, such as the discussion of acupuncture in this issue, the column will also address itself to topics closer to home. Galston will discuss his involvement in the growing movement to increase the social concern of scientists. And from time to time he will also delve into recent developments in plant biology, his specialty.



The second new column, "The Human Strategy," by **Marvin Harris**, will bring to our readers some of the fruits of current anthropological research. Harris, professor of anthropology at Columbia University, has been a leader in the rapidly expanding school of cultural ecology, which places a new emphasis on the relationship between human culture and the wider biophysical world. In this inaugural column, it is with this holistic approach that he examines man's persistence in making war on his own kind. Outspoken and often controversial, Harris's interests range from sacred cows (the real, Indian kind) to the rate of deposition of chewing gum on city sidewalks. He is currently studying patterns of domestic life in New York City. Harris has recently published *The Rise of Anthropological Theory* and a textbook, *Culture, Man, and Nature.*

Sir Frederick Treves was a lecturer in anatomy and surgery at London Hospital Medical College during the late 1800s. His skills made him surgeon to the ruling families of England and friend of kings, but his greatest satisfaction may have come as a writer. His moving report of the life of John Merrick, a grossly deformed and ridiculed man, was published in 1923, and it was shortly after that author and scientist **Ashley Montagu** first read the story. The value of love as an adaptive force became a central theme of Montagu's philosophy and Treves's original account of one man's triumph over incredible adversity, published in this issue, is the basis of Montagu's recent book, *The Elephant Man.*

Through his field work in Madagascar, where he examined the fossils of extinct lemurs and studied the behavior and ecology of surviv-

ing species, **Ian Tattersall** has been trying to trace the evolutionary divergence of man and apes. Assisted by the writings of the nineteenth-century French naturalist Grandidier, he has gathered a number of clues about the emergence of early man. Tattersall, an assistant curator of anthropology at The American Museum of Natural History, is a native of England and holds a Ph.D. in geology from Yale University.

To study the role of a particular color pattern in the life history of a bird, **Douglas G. Smith** needed a subject that was territorial, abundant, and polygamous. He chose the red-winged blackbird, and through his field work in Washington and Massachusetts, he discovered the purpose of the males' distinctive red epaulets. Smith received a

Ph.D. from the State University of New York at Stony Brook, where he is now an associate professor of biology. His next research project will be to study the importance of vocalizations in avian social systems.

The study of devil worship attracted **June Nash** to a locale where few gringas have been: 1,105 feet down in a Bolivian tin mine. There she witnessed the rituals with which the miners dispel their fears of an imminent and violent death. Nash, who is presently an associate professor of anthropology at New York University, has collaborated on a soon to be released film on the life of a tin miner. She plans to return to Bolivia to continue her studies of superstitition, religion, and ideology. Nash obtained a Ph.D. in anthropology from the University of Chicago, and has conducted field work in Mexico, Guatemala, and Burma.

As an undergraduate studying Latin, **Phillip Drennon Thomas** enjoyed reading Pliny as a "break from some of the tedium of Horace." This literary diversion developed into a scholarly affair. Thomas's fascination with all facets of natural history has led him to England and Scotland to study the history of marine biology. He also likes to poke about in Indian dwellings in New Mexico, *below,* in his spare time. An associate professor of history at Wichita State University, he is working on a monograph of Richard Burton, the explorer. His Ph.D. in medieval history was earned at the University of New Mexico.

The second of **George B. Schaller**'s three-part study of predation in the Serengeti region of Tanzania is based on observations he made of other large predators while studying the lion. Schaller is an associate of the Institute for Research in Animal Behavior of the New York Zoological Society and Rockefeller University.

Letters

Science of Metrocryonics

The fortuitous coincidence of your article on the freezing of human bodies and a recent trip to New York brought to my mind the suggestion of an analogous (and similarly optimistic) treatment of urban blight. Why not freeze our major cities until the time when urban experts and social scientists find solutions to the problems of overcrowding, high crime rates, pollution, social disenchantment, and other terminal "diseases" that plague urban centers? Special fluids might be perfused along the subway system to prevent further deterioration; sewage systems, water mains, etc., could be similarly treated, and dry ice packed around tall buildings. Large fans would then blow away residual pollution to prevent any "greenhouse effect."

A science of metrocryonics might also bring with it some unforeseen sociocultural advantages. Individuals who expect to awaken in the future with a mind 30 to 40 years out of date might justifiably expect to have a good deal of company, but if past history is any indication, the solution of urban problems will have to wait considerably longer than this. How much more sensible, then, to freeze whole populations, so that citizens can provide mutual support and reinforcement in the remote eons of the megathaw!

ROY WAGNER
Department of Anthropology
Northwestern University

Sophisticated Superstition: Dial Phones

While I rather enjoyed Spencer Klaw's personal look at B. F. Skinner ("B. F. Skinner's Brave New World," January, 1972), I feel that his review of *Beyond Freedom and Dignity* missed the essential scientific objection to behaviorism. He says in his review, "These concepts [ego, id, and superego], like the concept of the will, only get in the way of rational efforts to understand—that is, to predict and control—human behavior." The assumption that prediction and control constitute understanding is the fundamental point of dispute for many of Skinner's critics.

While understanding may confer predictability and control, the converse is certainly questionable. An automobile driver, for example, may be able to predict and control the direction of his vehicle with absolutely no understanding of suspension geometry, the physics of internal-combustion engines, or the mechanics of a drive train. Indeed, much of our modern life involves prediction and control with little or no understanding. We dial a telephone and hear a voice; we turn a knob and see an image on a television screen. That is, we perform certain rituals because they are followed by certain consequences. In this sense, our modern technological prediction differs only in reliability from burning a goat to assure a good harvest.

Hence, many behavioral scientists feel that the prediction and control sought by the behaviorist operate at the level of very sophisticated superstition. While they may achieve some very satisfactory practical results, they do little to further our understanding of human functioning and should therefore be distinguished from science.

HARRY FRANK
Department of Psychology
University of Michigan-Flint

The Pigeon Problem

I found Norman Woldow's article, "Pigeon and Man" (January, 1972) of interest, considering the large urbanized population of *Colomba livia* residing in my neighborhood.

Although the "spotty" aspect of the relationship between pigeon and man is of some concern, it should be mentioned that the common domestic pigeon is a carrier of psittacosis (ornithosis). This avian disease can be fatal, but infected birds may show only minimal evidence of the illness, such as ruffled feathers, lethargy, and a failure to eat. Birds with the active disease, as well as the asymptomatic carriers, are most likely to transmit the microbial agent to humans. Even birds that recover can transmit the agent for many months.

The most common route of infection from bird to man is through inhalation of infected dried excreta. The symptoms in humans are a transient influenza-like illness, but a serious pneumonic disease may be seen as well. Since the treatment and responses resemble other upper respiratory infections, a diagnosis of psittacosis is not often made. According to the New York City Health Department, psittacosis was reported six times in 1970, and only three times in 1971. It would be interesting to speculate how many cases go unreported, considering the numbers of pigeons that live here with us, and the abundance of dried excreta.

ADRIENNE SMITH
Beth Israel Medical Center
New York, New York

I found Dr. Woldow's article informative, but would like to make some observations. First, I have noticed that the common pigeon has quickly taken advantage of its original native cliff habitat where it has found it in America. I have noticed numbers of them nesting in the Palisade cliffs in New Jersey, exactly as their ancestors must have nested in Eurasia. Therefore, they might be considered as a new wild bird, not a commensal, as they are now.

Secondly, I disagree that modern architecture and skyscrapers have helped increase the pigeons' numbers. On the contrary, clean, modern, functional architecture offers them fewer niches and crannies in which to nest. Indeed, much modern architecture is deliberately planned to be "pigeon-proof." Another inhospitable factor in modern cities is the increasing use of "birth control grains" to limit their numbers. I foresee a gradual decline of their urban populations, perhaps until the time when large cities may hold only a minuscule flock or two, carefully warded as a memory of the past.

GEORGE ROWELL
New York, New York

I've long suspected that pigeons are about as intelligent as they look; now Norman Woldow's article in the January issue seems to bear me out.

If they roost in Chicago's Loop where Woldow says they do, because, in his words, "the winter wind is predominantly from the northwest, off Lake Michigan," they are indeed silly birds. Not that the wind is not from the northwest. It is—sweeping down from Canada's prairie provinces, through Minnesota and Wisconsin, and into the aptly named Windy City. But Lake Michigan is to the *east.*

If the wind were off the lake, Chicago's temperature would be much more moderate: cooler in summer, warmer in winter. However, the precipitation would be greater. Most birds would know this, but what can you expect of pigeons?

But perhaps I misjudge them. Maybe they roost away from the lake to be nearer City Hall where, as the legions of city employees know, sits the source of all warmth and light, friend to pigeon and payroller alike—hizzoner the Boss, Mayor Richard J. Daley.

JAMES PRYTOWSKI
Evanston, Illinois

Pop Tart Technology

In answer to Jerry O'Donnell's letter to the editor on technology (January, 1972), I would like to ask why, in spite of miracle drugs and improved surgical techniques, has the average life-span in America increased only four years since 1900? Because technology is creating diseases as fast as it is getting rid of them. In 1900 most people died of pneumonia, tuberculosis, or influenza. Today: cancer, stroke, heart disease. And these are on the increase, as are diabetes, hemophilia, and mental illness. Not to mention neuroses, pathological social behavior, crimes of violence. We no longer live in fear? Have you ever been to New York, Mr. O'Donnell?

Adelle Davis has called this nation the best fed and worst nourished. Technology and its brainchild, the advertising industry, fool people into believing that the food they shove down their throats is nutritious. The consumption of processed food now surpasses the consumption of unprocessed food in this country. Ask the people of Hunza, who often live more than 100 years, how many Pop Tarts they had for breakfast.

Insect "control" has created strains of poison-resistant mosquitoes and flies and contaminated many a lake full of edible fish. Insects pollinate crops and are an essential link in the food chain that leads right into our own mouths. I'm afraid the brave new world does need insects and plenty of them.

Technology is only a tool. So are guns. Guns don't pull their own triggers. Men do. I wonder if wresting the gun from the man's hand once and for all wouldn't be more effective than trying to set limits on when he can and cannot use it; particularly if the man is very powerful, sits in a high place, and has a vested interest in using it.

PATTY JO NELSON
Richmond, Maine

From Some Grateful Coyotes

Correspondent Jackie Cobo ("Letters," June-July, 1971), speculated about what might happen if your wolf record were played on a remote speaker outdoors.

Acting on the suggestion, we played ours one evening for some half-tame coyotes who frequent our grounds.

The result was a magnificent antiphonal concert, coyote treble answering wolf baritone in a truly virtuoso performance. We were irresistibly reminded of one of Haydn's "echo" divertimentos for two small orchestras.

The record has given us tremendous pleasure. We—and possibly the coyotes—are grateful.

AMANDA AND PHILIP DUNNE
Malibu, California

Down on the Farm

A letter from another farmer

by E. Raymond Hall

In the January, 1972, issue of NATURAL HISTORY MAGAZINE the letter from farmer J. O. Harvey urges "respect for the land . . . used to support us all" and succinctly catalogs half a dozen important sources of pollution. But she doesn't mention pesticides, possibly the single most important source of pollution facing us in the 1970s.

On the same evening, January 17, that I read the letter, I also read an Associated Press dispatch (*Kansas City Star*) crediting our new Secretary of Agriculture with stating that if pesticides were banned from farming, we could not feed all Americans. That dispatch followed the departmental line, as expressed by the administrator of the Research Service of the U. S. Department of Agriculture: "As we cope with . . . a more populous world . . . one of the greatest needs is production of food for billions of people. At present such production requires the use of pesticides" (*Science*, June 19, 1970).

The statement that pesticides are required to grow food crops is repeated so often by employees of the Department of Agriculture that many citizens believe it is true. Actually, it isn't. Individuals and local organizations of agriculturists in many parts of the United States have been, and are, demonstrating that the use of pesticides (herbicides and insecticides) is not necessary in food production.

One example is a 107-acre farm that I manage in Marysville Township, Miami County, Kansas. Five acres are pasture, 22 are woodland along a creek, and 80 are cultivated. No pesticides have ever been used on growing crops on this farm. Corn, milo, soybeans, and wheat are the crops raised now. For any given year in the period from 1886 through 1964 there was little or no difference in the yields from farms with comparable ground throughout the township. However, in the seven years since then, herbicides were introduced on neighboring farms and the yield per acre on my 80 acres has been greater than on comparable land, especially when soybeans were planted where corn had been grown the year before. On the comparable land, residues of herbicides applied to inhibit the growth of broad-leaved weeds in corn fields accumulate in the soil, causing the soybeans, themselves broad-leaved plants, to be puny. Other kinds of herbicides applied in order to inhibit the growth of grasses in soybean fields accumulate in the soil and cause the corn plants, themselves grasses, to be puny, especially when corn is planted where soybeans had been grown the year before.

The following paragraphs explain how application of herbicides results in smaller yields per acre.

The farmer who plants and harvests row crops on 500 acres (260 corn and 240 soybeans), by means of four-row machinery and without using pesticides, likely passes over the land eight times to prepare the seed bed, plant, cultivate, and harvest the crop. In doing this, he averages about 30 acres in a nine-hour day—more acres when disking and fewer when planting. For 100 bushels of corn per acre and 40 bushels of soybeans per acre he may gross $50,000 ($1 per bushel for corn and $2.50 per bushel for soybeans).

If the farmer attempts to eliminate weeds by spraying an herbicide once instead of by cultivating three times, he passes over the land a total of only six instead of eight times. This reduces his time spent in the field by 25 percent. The use of herbicides may reduce the yield per acre by 10 percent. Under these conditions, the farmer, who ordinarily wishes to produce in one year as many bushels as possible, attempts to rent 33⅓ percent more land (167 acres) and farm it (using herbicides) in the extra time he has. Even with a 10 percent reduction in yield per acre, from 667 acres (347 acres of corn and 320 of soybeans) he could gross $60,030—or $10,030 more than from 500 acres. But is there a better way to farm? (In 1971, the difference was 30 percent—79 vs. 113 bushels—on corn, but less than 30 percent on milo and soybeans. Corn blight lowered the yield in fields adjoining the land managed by me, which was blight-free. Presence or absence of blight is not known to be related to pesticides or their residues in the soils, however.)

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it would seem that, in Miami County, for each 2,500 acres of cultivated land there should be at least five instead of four farmers and that they should control weeds by cultivation and should not use pesticides. This system produces more bushels per acre and more total bushels.

Furthermore, under this system the fish in the creek grow big and do not die prematurely because of pesticide residues, which have already stilled the spring voices of five bird species in the woodland on and around the land that I manage.

The example outlined above is only one strand of the web that regulates the lives of man, other animals, and plants in the current green (agricultural) revolution, but illustrates why I am very tired of being informed that pesticides are required to grow enough food crops.

I yield to the temptation to comment upon two other points made by the administrator of the Agricultural Research Service in his article in *Science*. First, with respect to certain newly developed dangerous pesticides, the administrator of the USDA's Research Service wrote that "scientists argue their data and conclusions . . . until shreds of truth can be aggregated to establish the fact" that use of those pesticides should or should not be banned. To my way of thinking, the reverse procedure is in order: that is, those pesticides should be banned until exhaustive testing proves their use to be in the public interest.

Second, his statement that "no data on humans are available" concerning the effects of the herbicide 2,4,5-T is surprising because some acquaintances of mine who used considerable amounts of it became ill and died shortly after. They reported having been told at the clinics where they went for treatment that their illness and accompanying blood dyscrasia probably resulted from 2,4,5-T. In my immediate neighborhood such information circulates by word of mouth, and as a consequence less 2,4,5-T is used than agents of the U.S. Department of Agriculture recommend. Many persons feel that, as one farmer put it, "If you'll notice, a fellow who uses a lot of that brush killer is apt to die in about six months of leukemia." ■

Attitudes on Acupuncture

Reports about a Chinese medical technique didn't exactly set some American scientists on pins and needles

by Arthur W. Galston

A funny thing happened to me on the way back from Peking, where, together with Ethan Signer of the Massachusetts Institute of Technology, I had been one of the first two American scientists to visit since 1949. Impressed by the obvious improvements in the physical conditions of life of the Chinese people; by the virtual abolition of hunger, disease, floods, and drought; by the dynamism of the workers in factories and, especially, on the communes; and by the incredible alterations in education and research wrought by the Cultural Revolution, we were eager to talk often and at length about these and other things we had seen during our eventful visit to the People's Republic of China. By chance, during the initial interview with representatives of the press, radio, and television upon our arrival at Kennedy Airport on May 25, 1971, we happened to mention that we had witnessed in Peking four major operations performed with acupuncture needles as the sole anesthetic agents. We had intended this piece of news as one illustration of the fact that the Chinese know some things that we didn't know, and that any scientific exchanges with them would therefore be of benefit to both parties. But the remark was not accepted in that context, and since that first interview, acupuncture has become, perforce, one of the major topics discussed whenever we have appeared to talk about our journey to China. Furthermore, the discussions have become complicated by an acrimony we had not anticipated. It is no exaggeration to say that professional friends of long standing began to doubt our judgment and took to "needling" us because we apparently believed what we had seen and been told about acupuncture.

We were aware, of course, that acupuncture is not a new development and that it has been used in various ways for more than 4,000 years, mainly in China. Allegedly originated by the chance discovery that arrows shot into one part of a soldier's body could produce loss of sensation in other parts of the body, acupuncture developed into a therapeutic technique in which very slender and flexible needles are inserted into discrete parts of the body; they are then rotated or twisted gently so as to produce stimulation at some desired depth below the surface and a subsequent loss of sensation elsewhere. Over the years, acupuncture has developed into a reasonably well-organized body of empirical knowledge. Some 365 effective points in the body are generally recognized, although we were told that the number has been expanded to about 1,000 during the last few years of the Cultural Revolution. This has occurred mainly through the volunteer efforts of members of the People's Liberation Army who probed their own bodies with fine needles. Insertion of the delicate needles into the effective points is reported to produce loss of sensation in very specific and localized areas, frequently at great distances from the point of insertion of the needle. The needles are not especially painful to insert, nor is there any unpleasant aftereffect. The technique is said to be useful for relieving distress caused by such ailments as arthritis, tension, convulsions, and migraine headaches, and is much used for these purposes in China, in other Asian countries, and to a certain extent in France, Germany, and elsewhere on the European continent. It has never found much favor in Britain, the United States, or other countries in the Western Hemisphere, although a College of Acupuncture has recently been established in Vancouver, British Columbia, staffed mainly by Oriental practitioners.

The reluctance of the Western world to accept acupuncture has resulted partly from the fact that it is not always successful and partly because analgesic drugs and other convenient pain-killing devices are available to us. Especially difficult

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to accept has been the body of theory that accompanies the practice; the Chinese explanations are based on acupuncture's effect on internal adjustment of the relative contributions of Yin and Yang essences and upon restoration of the balance of poorly characterized bodily forces and "humors." To Western medicine, this seems mystical, inconsistent with known facts of anatomy and physiology, and internally contradictory. The "meridional points" on the body into which acupuncture needles can be inserted with effect do not coincide with any known anatomical structure. Somewhat more than half of them do lie along obvious and well-described neural pathways, but others have no relation to the position of nerves. This lack of an adequate body of theory to account satisfactorily for the efficacy of the described points has led, inevitably, to a rejection by Western doctors of the alleged efficacy itself. Thus, we were not surprised that acupuncture has not enjoyed much esteem in the Western world, and that many Western physicians were ready to write it off as being completely without therapeutic value.

Our entry into this situation was certainly fortuitous and accomplished under suboptimal conditions. There we were, unexpectedly in Peking, a molecular biologist and a plant physiologist, being shown a startling new advance in anesthetic technology that had not been witnessed by any Western physicians. We were both innocent of the Chinese language, of medical knowledge and of anesthetic techniques, and had had no opportunity to prepare ourselves for what we were witnessing. Yet what we saw was so startling, so direct, and apparently so easy to understand that we did not think we should shrink from describing it when we returned.

The situation was this: We had requested a visit to a Chinese hospital so that we could come back with some impression of the status of Chinese medicine. Our hosts had arranged a visit for us to Hospital No. 3 affiliated with Peking Medical College. During the briefing session, when the hospital was being described to us, we were asked whether we would care to witness several operations performed with a new anesthetic technique. When we gave our assent, we were taken to an upstairs room where, after the usual scrubbing up and donning of sterilized white robes, we were admitted to an operating theater. After a few minutes, a young man requiring a hernia operation was wheeled into the room. He was lively and alert, apparently not worried about the operation, grateful to be in such a fine hospital, and quite happy to talk to us through an interpreter. In a little while, the surgeon and some technicians examined him, conferred briefly, and then marked on the calves of the legs and on his abdomen locations at which the acupuncture needles were to be inserted. The needles were then deftly put in at the marked places and gently manipulated until the patient indicated some numbing of his body. Then, to our surprise, the needles were attached to delicate wires leading to an electrical junction box, which we surmised was battery operated. Then, for twenty minutes, a 0.5 milliampere current was permitted to flow from the 5-volt source. At the end of this time, the appropriate abdominal area was probed by the surgeon. Since it was completely anesthetized, he made the incision and began the operation. To laymen, he seemed very skilled and the team of nurses and technicians very crisp and efficient. The patient remained awake and alert throughout, and both the doctors and we were able to converse with him from time to time. We left as he was being sewed up.

We then proceeded in turn to three other operating theaters, where we witnessed operations for removal of a gastric ulcer, a thyroid tumor, and an ovarian tumor. This last operation was perhaps the most spectacular. The young woman involved was unusually cheerful and confident. When she heard the surgeon remark that the tumor had been successfully removed, she asked to see it. We have a fine photograph of her looking with interest at the baseball-sized tumor held in a porcelain tray near her head as the surgeons are stitching up the lower part of her body.

We were not able, in our brief stay in China, to follow the further fate of these patients, but we were told that most patients make a speedy and uneventful recovery.

Continued on page 92

An Apache Indian child. A family of six in a tiny two-room house. No water. No heat. No electricity. In the center of this desolation Erlinda Cosay. A child of five. A child who hasn't seen her father since she was three. A child who must travel four miles a day to school. A child whose last dress was a castoff. Erlinda needs your help so she can help herself. And through Save the Children Federation you can give her that help. For $15.00 a month you can sponsor an American Indian child like Erlinda. So that there can be electricity in the house instead of kerosene and wood. So Erlinda can have a new dress. And books. So Erlinda's neighbors can improve their village. With a community well. A new road. Perhaps a laundromat. To make money to buy necessities to make dependent people independent. And for you there's even more. The chance to correspond with a child. To receive a photograph. And progress reports. Erlinda's mother instructs her in tribal customs, so Erlinda can learn about her past. Won't you help her learn about her future?

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Warfare Old and New

Since the original reasons for war are no longer valid, why does it persist?

by Marvin Harris

Warfare, as many of us will grimly acknowledge, is unique to mankind. No other animal engages in the organized slaughter of adjacent populations of its own species. It would almost seem that evolutionary theory predicts that warfare is impossible, for how can natural selection favor a trait that involves predation *within* the species?

The fact that warfare is uniquely human should immediately dispel the currently popular belief—generated by Konrad Lorenz and Robert Ardrey, among others—that we go to war because of our aggressive animal instincts. The fiercest socially organized predators such as lions, hyenas, and wolves are aggressive, but they don't make war. Therefore, the explanation for warfare cannot be found in the traits that we share with other animals, such as the capacity to become violent, but rather in the traits that we don't share with them. The causes of war must be associated with some peculiarity of culture, man's primary evolutionary mode of adapting to natural conditions.

I am becoming more and more convinced that to understand the causes of warfare we must first distinguish between the functions of warfare in primitive and in modern contexts. What does it accomplish? Among most primitive peoples warfare was an adaptive cultural response to ecological conditions. There was no alternative that did not also involve premature death. Primitive warfare arose as part of a complex system that prevented human populations from exceeding the carrying capacity of their habitats. For a human group with a given level of technology, carrying capacity means the maximum population that can be sustained in an area without inducing irreversible degradation of the ecosystem. Typically, the approach toward the limit of carrying capacity among primitives first manifests itself in a reduction in the efficiency of food production: a unit of labor produces a smaller yield. Sooner or later the population must be limited if the group is to remain viable.

With primitive technology, all methods of population control are either unreliable or lethal. For contraception, primitives are limited to coitus interruptus, a highly unreliable technique at best. As for abortions, they are both unreliable and dangerous. The principal techniques consist of administering an herbal poison to the pregnant woman, tying her with tight bands, or jumping on her lower abdomen. These practices reduce the infant population, but they also kill off a substantial portion of the adult women.

In the absence of an effective contraceptive technology, the easiest way to limit population is to expose a group's infants to the effects of the approaching ecological pinch. Simple neglect of babies is perhaps the most common form of population control. This will begin to take effect at a point well below maximum carrying capacity as mothers, burdened by extra work, become less responsive to the demands of their children. The babies cry unattended for longer periods and the mothers nurse them less effectively or less often. In ecological perspective, the line separating infant neglect from infanticide is extremely thin. In few primitive cultures will the members admit that the murder of children is common. But unconscious deprivations can exert as much influence on infant mortality as deliberate infanticide.

Now we come to the heart of the problem. To be an effective means of population control, infant mortality must affect girls rather than boys. All the male children can survive to reproductive age without increasing population as long as the number of females and their average fertility remain constant. In a recent survey of the censuses of 112 primitive populations, anthropologist William T. Divale showed that in juvenile age categories there was an average of 146 males to 100 females. Among groups still practicing warfare, the ratio of adult males to females fell to less than 110:100, indicating a high rate of mortality for adult males. Against the background of detailed case studies, such as Napoleon Chagnon's work with the Yanomamö in Venezuela, these figures strongly suggest a systemic relationship between culturally induced female infant mortality and primitive warfare.

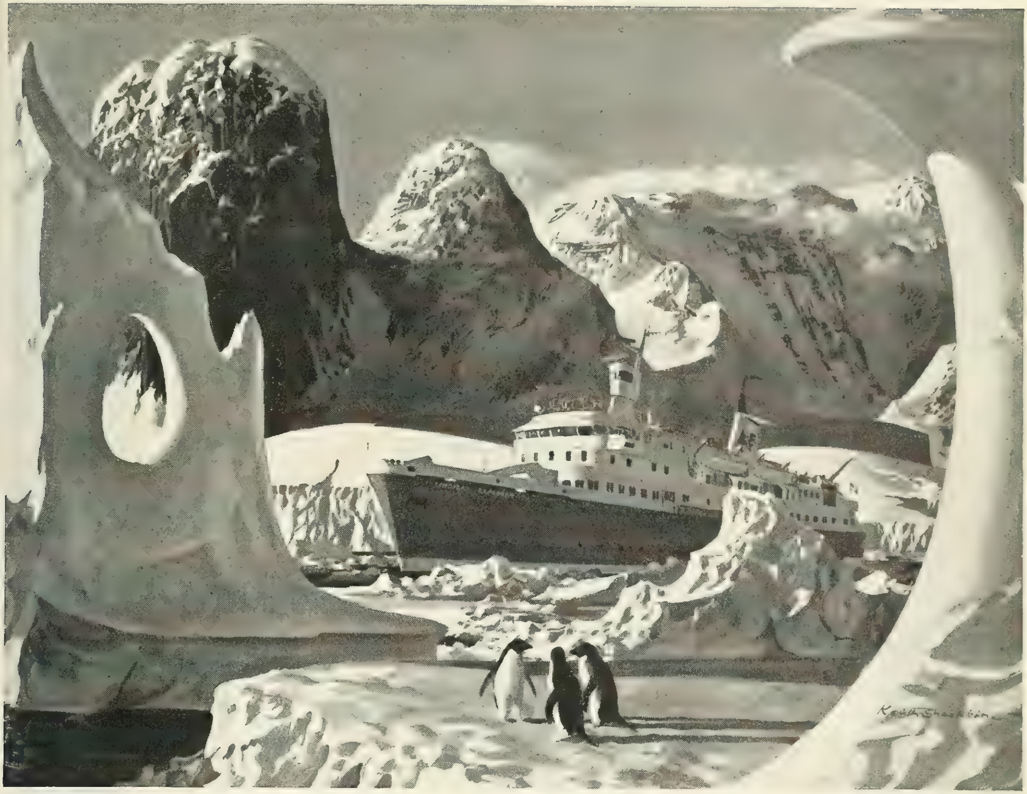
I believe this relationship can be explained as follows: The severe imbalance between the sexes is socially unstable. Sooner or later, as among the Yanomamö, groups raid their neighbors to steal each other's women. Once this raiding, or warfare, begins it encourages more female infant mortality, since warfare places a premium on expanding the male infant population. Human warfare itself may not be adaptive, but female infant mortality is. Thus the primary function of primitive warfare is not to kill off "surplus" males but to insure the continuation

of high levels of female infant mortality. Much of what we nowadays regard as male chauvinism has its roots in this situation. One conclusion that I draw from this is that the whole complex of masculine aggressiveness is a by-product, not a cause of war.

Unpleasant as it may be, it is difficult to avoid the conclusion that warfare began as part of an ecologically adaptive system of population control. Death through combat strikes us as wasteful; yet for primitive peoples the alternative to war for balancing the adult sex ratios was the expansion of male infant mortality.

I hasten to add that my analysis of warfare in the present century leads to an entirely different conclusion. Today we are confronted with equal rates of male and female infant mortality, and a steady decline in both. This has created the modern population explosion, itself a response to the higher carrying capacities possible with modern technology. For a long time now in modern societies, warfare and selective female infant mortality have been unhinged. As a result, modern warfare, contrary to popular Malthusian doctrines, has ceased to be an effective means of population control. Each of the major wars of this century—World War I, II, Korea, and Vietnam—has failed to reduce the rate of growth of the combatant populations. Despite the scale of slaughter, the fertility of the female survivors has easily made up for the losses in combat. For example, the population of South Vietnam grew at the phenomenally high rate of 3 percent a year during the past decade.

We are all aware that the means for making more efficient wars are available and that a nuclear exchange could readily achieve a catastrophic decline in world population. At least temporarily, however, the link between war and population control has been broken. At the same time, advances in contraception technology provide us with an alternative to infant mortality that need not involve a single premature human death. Why then does warfare persist? I shall have to postpone my answer, concluding for the moment only that neither instincts nor population can serve as reasons. ■



The Elephant Man

by Sir Frederick Treves

For most of his life, John Merrick was ridiculed and tormented. Yet the soul of a butterfly continued to flutter in his monstrous form

Postscript by Ashley Montagu

In the Mile End Road, opposite to the London Hospital, there was (and possibly still is) a line of small shops. Among them was a vacant greengrocer's which was to let. The whole of the front of the shop, with the exception of the door, was hidden by a hanging sheet of canvas on which was the announcement that the Elephant Man was to be seen within and that the price of admission was twopence. Painted on the canvas in primitive colors was a life-size portrait of the Elephant Man. This very crude production depicted a frightful creature that could only have been possible in a nightmare. It was the figure of a man with the characteristics of an elephant. The transfiguration was not far advanced. There was still more of the man than of the beast. This fact—that it was still human—was the most repellent attribute of the creature. There was nothing about it of the pitiableness of the misshapened or the deformed, nothing of the grotesqueness of the freak, but merely the loathing insinuation of a man being changed into an animal. Some palm trees in the background of the picture suggested a jungle and might have led the imaginative to assume that it was in this wild that the perverted object had roamed.

When I first became aware of this phenomenon the exhibition was closed, but a well-informed boy sought the proprietor in a public house and I was granted a private view on payment of a shilling. The shop was empty and grey with dust. Some old tins and a few shrivelled potatoes occupied a shelf and some vague vegetable refuse the window. The light in the place was dim, being obscured by the painted placard outside. The far end of the shop—where I expect the late proprietor sat at a desk—was cut off by a curtain or rather by a red tablecloth suspended from a cord by a few rings. The room was cold and dank, for it was the month of November. The year, I might say, was 1884.

The showman pulled back the curtain and revealed a bent figure crouching on a stool and covered by a brown blanket. In front of it, on a tripod, was a large brick heated by a Bunsen burner. Over this the creature was huddled to warm itself. It never moved when the curtain was drawn back. Locked up in an empty shop and lit by the faint blue light of the gas jet, this hunched-up figure was the embodiment of loneliness. It might have been a captive in a cavern or a wizard watching for unholy manifestations in the ghostly flame. Outside the sun was shining and one could hear the footsteps of the passers-by, a tune whistled by a boy and the companionable hum of traffic in the road.

The showman—speaking as if to a dog—called out harshly: "Stand up!" The thing arose slowly and let the blanket that covered its head and back fall to the ground. There stood revealed the most disgusting specimen of humanity that I have ever seen. In the course of my profession I had come upon lamentable deformities of the face due to injury or disease, as well as mutilations and contortions of the body depending upon like causes; but at no time had I met with such a degraded or perverted version of a human being as this lone figure displayed. He was naked to the waist, his feet were bare, he wore a pair of threadbare trousers that had once belonged to some fat gentleman's dress suit.

From the intensified painting in the street I had imagined the Elephant Man to be of gigantic size. This, however, was a little man below the average height and made to look shorter by the bowing of his back. The most striking feature about him was his enormous and misshapened head. From the brow there projected a huge bony mass

From *The Elephant Man* by Ashley Montagu, published by Outerbridge & Dienstfrey.

like a loaf, while from the back of the head hung a bag of spongy, fungous-looking skin, the surface of which was comparable to brown cauliflower. On the top of the skull were a few long lank hairs. The osseous growth on the forehead almost occluded one eye. The circumference of the head was no less than that of the man's waist. From the upper jaw there projected another mass of bone. It protruded from the mouth like a pink stump, turning the upper lip inside out and making of the mouth a mere slobbering aperture. This growth from the jaw had been so exaggerated in the painting as to appear to be a rudimentary trunk or tusk. The nose was merely a lump of flesh, only recognizable as a nose from its position. The face was no more capable of expression than a block of gnarled wood. The back was horrible, because from it hung, as far down as the middle of the thigh, huge, sack-like masses of flesh covered by the same loathsome cauliflower skin.

The right arm was of enormous size and shapeless. It suggested the limb of the subject of elephantiasis. It was overgrown also with pendent masses of the same cauliflower-like skin. The hand was large and clumsy—a fin or paddle rather than a hand. There was no distinction between the palm and the back. The thumb had the appearance of a radish, while the fingers might have been thick, tuberous roots. As a limb it was almost useless. The other arm was remarkable by contrast. It was not only normal but was, moreover, a delicately shaped limb covered with fine skin and provided with a beautiful hand which any woman might have envied. From the chest hung a bag of the same repulsive flesh. It was like a dewlap suspended from the neck of a lizard. The lower limbs had the characters of the deformed arm. They were unwieldy, dropsical looking and grossly misshapen.

To add a further burden to his trouble the wretched man, when a boy, developed hip disease, which had left him permanently lame, so that he could only walk with a stick. He was thus denied all means of escape from his tormentors. As he told me later, he could never run away. One other feature must be mentioned to emphasize his isolation from his kind. Although he was already repellent enough, there arose from the fungous skin-growth with which he was almost covered a very sickening stench which was hard to tolerate. From the showman I learnt nothing about the Elephant Man, except that he was English, that his name was John Merrick and that he was twenty-one years of age.

As at the time of my discovery of the Elephant Man I was the Lecturer on Anatomy at the Medical College opposite, I was anxious to examine him in detail and to prepare an account of his abnormalities. I therefore arranged with the showman that I should interview his strange exhibit in my room at the college. I became at once conscious of a difficulty. The Elephant Man could not show himself in the streets. He would have been mobbed by the crowd and seized by the police. He was, in fact, as secluded from the world as the Man with the Iron Mask. He had, however, a disguise, although it was almost as startling as he was himself. It consisted of a long black cloak which reached to the ground. Whence the cloak had been obtained I cannot imagine. I had only seen such a garment on the stage wrapped about the figure of a Venetian bravo. The recluse was provided with a pair of bag-like slippers in which to hide his deformed feet. On his head was a cap of a kind that never before was seen. It was black like the cloak, had a wide peak, and the general outline of a yachting cap. As the circumference of Merrick's head was that of a man's waist, the size of this headgear may be imagined. From the attachment of the peak a grey flannel curtain hung in front of the face. In this mask was cut a wide horizontal slit through which the wearer could look out. This costume, worn by a bent man hobbling along with a stick, is probably the most remarkable and the most uncanny that has as yet been designed. I arranged that Merrick should cross the road in a cab, and to insure his immediate admission to the college I gave him my card. This card was destined to play a critical part in Merrick's life.

I made a careful examination of my visitor the result of which I embodied in a paper. I made little of

the man himself. He was shy, confused, not a little frightened and evidently much cowed. Moreover, his speech was almost unintelligible. The great bony mass that projected from his mouth blurred his utterance and made the articulation of certain words impossible. He returned in a cab to the place of exhibition, and I assumed that I had seen the last of him, especially as I found next day that the show had been forbidden by the police and that the shop was empty.

I supposed that Merrick was imbecile and had been imbecile from birth. The fact that his face was incapable of expression, that his speech was a mere spluttering and his attitude that of one whose mind was void of all emotions and concerns gave grounds for this belief. The conviction was no doubt encouraged by the hope that his intellect was the blank I imagined it to be. That he could appreciate his position was unthinkable. Here was a man in the heyday of youth who was so vilely deformed that everyone he met confronted him with a look of horror and disgust. He was taken about the country to be exhibited as a monstrosity and an object of loathing. He was shunned like a leper, housed like a wild beast, and got his only view of the world from a peephole in a showman's cart. He was, moreover, lame, had but one available arm, and could hardly make his utterances understood. It was not until I came to know that Merrick was highly intelligent, that he possessed an acute sensibility and—worse than all—a romantic imagination that I realized the overwhelming tragedy of his life.

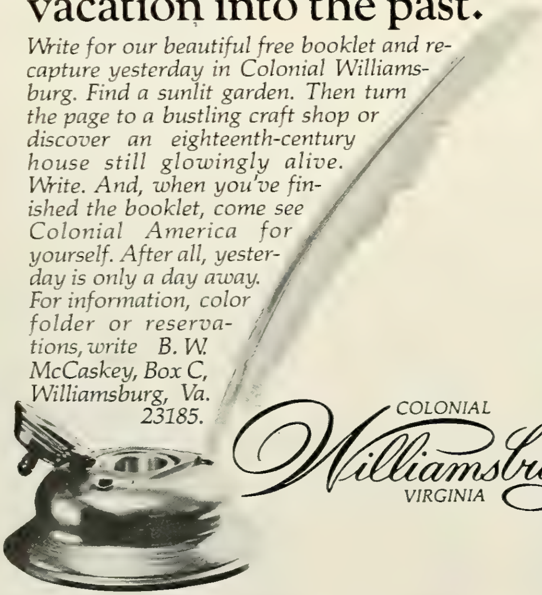
The episode of the Elephant Man was, I imagined, closed; but I was fated to meet him again—two years later—under more dramatic conditions. In England the showman and Merrick had been moved on from place to place by the police, who considered the exhibition degrading and among the things that could not be allowed. It was hoped that in the uncritical retreats of Mile End a more abiding peace would be found. But it was not to be. The official mind there, as elsewhere, very properly decreed that the public exposure of Merrick and his deformities transgressed the limits of decency. The show must close.

The showman, in despair, fled with his charge to the Continent. Whither he roamed at first I do not know, but he came finally to Brussels. His reception was discouraging. Brussels was firm; the exhibition was banned; it was brutal, indecent and immoral, and could not be permitted within the confines of Belgium. Merrick was thus no longer of value. He was no longer a source of profitable entertainment. He was a burden. He must be got rid of. The elimination of Merrick was a simple matter. He could offer no resistance. He was as docile as a sick sheep. The impresario, having robbed Merrick of his paltry savings, gave him a ticket to London, saw him into the train and no doubt in parting condemned him to perdition.

His destination was Liverpool Street. The journey may be imagined. Merrick was in his alarming outdoor garb. He would be harried by an eager mob as he hobbled along the quay. They would run ahead to get a look at him. They would lift the hem of his cloak to peep at his body. He would try to hide in the train or in some dark corner of the boat, but never could he be free from that ring of curious eyes or from those whispers of fright and aversion. He had but a few shillings in his pocket and nothing either to eat or drink on the way. A panic-dazed dog with a label on his collar would have received some sympathy and possibly some kindness. Merrick received none.

What was he to do when he reached London? He had not a friend in the world. He knew no more of London than he knew of Peking. How could he find a lodging, or what lodging-house keeper would dream of taking him in? All he wanted was to hide. What most he dreaded were the open street and the gaze of his fellow-men. If even he crept into a cellar the horrid eyes and the still more dreaded whispers would follow him to its depths. Was there ever such a homecoming!

At Liverpool Street he was rescued from the crowd by the police and taken into the third-class waiting-room. Here he sank on the floor in the darkest corner. The police were at a loss what to do with him. They had dealt with strange and mouldy tramps, but never with such



an object as this. He could not explain himself. His speech was so maimed that he might as well have spoken in Arabic. He had, however, something with him which he produced with a ray of hope. It was my card.

The card simplified matters. It made it evident that this curious creature had an acquaintance and that the individual must be sent for. A messenger was dispatched to the London Hospital which is comparatively near at hand. Fortunately I was in the building and returned at once with the messenger to the station. In the waiting-room I had some difficulty in making a way through the crowd, but there, on the floor in the corner, was Merrick. He looked a mere heap. It seemed as if he had been thrown there like a bundle. He was so huddled up and so helpless looking that he might have had both his arms and his legs broken. He seemed pleased to see me, but he was nearly done. The journey and want of food had reduced him to the last stage of exhaustion. The police kindly helped him into a cab, and I drove him at once to the hospital. He appeared to be content, for he fell asleep almost as soon as he was seated and slept to the journey's end. He never said a word, but seemed to be satisfied that all was well.

In the attics of the hospital was an isolation ward with a single bed. It was used for emergency purposes—for a case of delirium tremens, for a man who had become suddenly insane or for a patient with an undetermined fever. Here the Elephant Man was deposited on a bed, was made comfortable and was supplied with food. I had been guilty of an irregularity in admitting such a case, for the hospital was neither a refuge nor a home for incurables. Chronic cases were not accepted, but only those requiring active treatment, and Merrick was not in need of such treatment. I applied to the sympathetic chairman of the committee, Mr. Carr Gomm, who not only was good enough to approve my action but who agreed with me that Merrick must not again be turned out into the world.

Mr. Carr Gomm wrote a letter to *The Times* detailing the circumstances of the refugee and asking for money for his support. So generous is the English public that in a

few days—I think in a week—enough money was forthcoming to maintain Merrick for life without any charge upon the hospital funds. There chanced to be two empty rooms at the back of the hospital which were little used. They were on the ground floor, were out of the way, and opened upon a large courtyard called Bedstead Square, because here the iron beds were marshalled for cleaning and painting. The front room was converted into a bed-sitting room and the smaller chamber into a bathroom. The condition of Merrick's skin rendered a bath at least once a day a necessity, and I might here mention that with the use of the bath the unpleasant odor to which I have referred ceased to be noticeable. Merrick took up his abode in the hospital in December 1886.

Merrick had now something he had never dreamed of, never supposed to be possible—a home of his own for life. I at once began to make myself acquainted with him and to endeavor to understand his mentality. It was a study of much interest. I very soon learned his speech so that I could talk freely with him. This afforded him great satisfaction, for, curiously enough, he had a passion for conversation, yet all his life had had no one to talk to. I—having then much leisure—saw him almost every day, and made a point of spending some two hours with him every Sunday morning when he would chatter almost without ceasing. It was unreasonable to expect one nurse to attend to him continuously, but there was no lack of temporary volunteers. As they did not all acquire his speech it came about that I had occasionally to act as an interpreter.

I found Merrick, as I have said, remarkably intelligent. He had learned to read and had become a most voracious reader. I think he had been taught when he was in hospital with his diseased hip. His range of books was limited. The Bible and Prayer Book he knew intimately, but he had subsisted for the most part upon newspapers, or rather upon such fragments of old journals as he had chanced to pick up. He had read a few stories and some elementary lesson books, but the delight of his life was a romance, especially a love romance.

Continued on page 84

Of Lemurs and Men

by Ian Tattersall

A century has passed since Alfred Grandidier visited Madagascar to study these prosimians. Far scarcer now, in another hundred years these living cousins of man's earliest forerunners will likely have vanished altogether. Ah, the pity of it all

On a hot, dank day in 1866, a young Frenchman poked his way through an almost impenetrable tangle of vegetation in a rain forest on the island of Madagascar. Occasionally he caught a glimpse of the sky through the leafy umbrella of trees. but he concentrated mainly on the branches about him, trying to spot the furry figures overhead. Alfred Grandidier was looking for lemurs. Grandidier, the son of wealthy parents, had traveled widely in both hemispheres before visiting Réunion, a small French island near Madagascar, in 1865. There he learned more of the large island to the west and of its interesting human and animal inhabitants.

At that time, Madagascar was ruled from the island's capital, Tananarive, by the xenophobic Queen Rasoherina, and each time Grandidier tried to penetrate the interior, he was stopped. Reluctantly, he returned to Réunion, after having surveyed the flora, fauna, and geography of only the coastal regions of Madagascar. The following year, 1866, he visited the southern part of the island, an area that had never fallen completely under the influence of the Tananarive government. After a year spent in travel and study, he returned to France, taking back with him collections of preserved plant and animal specimens, together with living lemurs and other animals he had captured.

After a brief period at home, however, he was soon drawn back to Madagascar. The death of Rasoherina in 1868 allowed him to explore much more of the island. Continuing his studies of the natural history of the region, he collected numerous ethnographical, botanical, and zoological specimens, including the preserved bones and skins of lemurs. Unfortunately, his travels were abruptly curtailed by the outbreak of the Franco-Prussian War in 1870.

But the island continued to dominate his life. In 1871 he conceived the plan for his monumental *Histoire physique, politique et naturelle de Madagascar.* Written in collaboration with specialists in many fields, it covers the history, anthropology, geography, botany, and zoology of Madagascar. Its twenty-seven illustrated volumes were published between 1875 and 1930, but Grandidier, who died in 1921, never saw the final volume.

Except for a few slight inaccuracies, the illustrations of lemurs (some of which are reproduced here) are quite reliable representations of the living animals. In fact, in the case of several rare species, these pictures may be the best we will ever have. Even for the more common kinds, good photographs of lemurs in the wild are extremely difficult to obtain, as I discovered when, one hundred years after Grandidier had explored the forests of Madagascar, I, too, went there to study lemurs.

My initial impressions of the island are still vivid. From thirty thousand feet, the center of the island, the world's fourth largest, looks brown and dead. The land is pocked and scarred by canyons and eroded gullies, like a lifeless hulk torn and battered by the elements. In places, jagged outcrops of resistant igneous rock rise above the wasted plateau. Every year the rains fill the canyons and gullies with rushing water, carrying yet more precious soil to the sea. The few trees left in this area cling to the sides of stream channels.

It hardly seemed possible that this was the land that for millions of years had provided a refuge for lemurs—distant, forest-dwelling relatives of man. Nevertheless, even though the high central plateau has been largely denuded of trees by human activities, forested regions still exist on the island, particularly in the east and on the surrounding coastal lowlands. It was in these small patches of rain forest that I began my search for living lemurs in 1969.

Two thousand years ago, in the forests that then covered nearly the entire island, a traveler in Madagascar would have seen an enormous diversity of lemurs. Some of these prosimians, or lower primates, were large and browsed on the ground like baboons; others, yet larger, hung from the branches and fed like orangutans. Smaller forms scurried along the branches on all fours, while still others, the long-legged species, leaped phenomenal distances between vertical tree trunks. And the traveler who saw these would have observed but a fraction of the lemurs then living.

At the beginning of the Jurassic period, some 180 million years ago, Madagascar undoubtedly was a part of Africa. Toward the end of the Jurassic a large land mass gradually began to rift apart from Africa's east coast, although it probably wasn't until about 70 million years ago that the new island actually began to move

Bocourt et Faguet pinx.t

Imp. Becquet à Paris.

Propithecus verreauxi deckeni

away from the continent. For some 30 million years this drift persisted, until Madagascar reached its present position 250 miles off the coast of Mozambique.

It seems unlikely that the order Primates had begun to differentiate from archaic mammal stocks before the time that Madagascar became an island, so the question naturally arises, Where did the lemurs come from? Today there are large East African rivers, such as the Zambezi and Limpopo, that drain into the Mozambique Channel, washing large rafts of vegetation far out to sea. Sometimes animals are found riding the waves on this debris. Almost the only conceivable way the ancestors of lemurs could have arrived in Madagascar would have been by clinging to such rafts, an easy thing for animals with grasping hands and feet to do. This accidental mode of transportation also seems feasible since Madagascar drifted in a generally southward direction, almost parallel to the African coast, and for most of its journey was probably much closer to the continent than it is today.

No one has yet found fossils of appropriate age either in Africa or in Madagascar, so not much is known about these lemur ancestors. Based on comparative studies of their descendants, however, it is likely that at least two, and possibly three, different lines of ancestral prosimians gave rise to living lemurs. A few prosimian genera still exist on the African mainland and in Asia, but only on Madagascar, in the virtual absence of predation and competition, have the prosimians evolved into so diverse an array of forms. Today, the largest

Keulemans pinx.[t] *Imp. Becquet fr. Paris.*

Lemur catta

Bocourt et Faguet pinx.[t]

Imp. Becquet à Paris.

Avahi laniger

Bocourt et Faguet pinx.[t]

Imp. Becquet à Paris.

Propithecus verreauxi coronatus

lemur has the bulk of a medium-sized dog, while the smallest is no larger than a mouse. Approximately nineteen species still live in the Madagascar forests, but a thousand years ago, the number was closer to thirty-two. Subfossil, or partially fossilized, remains of more than a dozen now-extinct species have been found in deposits radioactively dated to between 2,850 and 980 years ago.

The lemurs' peaceful world ended when man arrived on Madagascar. No one is certain who these first men were or exactly when they came, although legends tell of a mysterious people called Vazimba whose origins are obscure. Modern Malagasy are mostly descendants of immigrants from the Indonesian region, refugees from the east who probably began to arrive on Madagascar less than two thousand years ago. Since then, other groups of people have migrated from the Arabian peninsula and Africa.

After about 50 million years of isolation, the lemurs were hopelessly ill-prepared to cope with this influx of humans. Within a relatively short time, the large lemurs and the purely terrestrial ones had disappeared, along with some of the smaller species.

Surprisingly, there is little direct evidence that associates man with the subfossil lemurs, although some pottery fragments have been found suspiciously near the bones of extinct lemurs at a site in south-central Madagascar. At another site on the southern tip of the island, the skull of one prosimian, *Archaeolemur*, turned up. It had apparently been killed with an ax.

Keulemans pinx.[t]

Imp. Becquet fr. Paris.

Lemur variegatus

Bocourt et Faguet pinx.[t] *Imp. Becquet à Paris.*

Propithèques de Verreaux

Folktales, some still current among various Malagasy, tell of creatures that might bear relationship to now-extinct lemurs. Among the Bara people of southwest Madagascar, for example, there is the legend of the Kalanoro, little men with long hair, said to be agile runners and climbers inhabiting the forests and emerging from them at night to raid local villages for food. It is possible that the once wide-ranging, small-baboon-sized lemur *Hadropithecus* gave birth to the Kalanoro legend. Certainly Madagascar's first human inhabitants saw *Hadropithecus,* and no doubt were largely responsible for its demise.

In 1658, four large animals difficult to identify with any living lemurs appeared in brief but intriguing descriptions by Sieur Etienne de Flacourt in his *Histoire de la Grande Isle Madagascar.* For many years during the seventeenth century Flacourt, a representative of the king of France, maintained a base at Fort-Dauphin in the south of the island. Not all his data were culled from personal experience; some of it came from information supplied by local Malagasy. But in the light of later investigation, his descriptions seem to be fairly accurate. One of these reads:

> Tretretretre, or tratratratra, an animal as big as a two-year-old calf, with a round head and the face of a man. It has wooly hair, a short tail and eyes like those of a man. . . . It can be seen near the Lipomani Lake, in the region of which is its lair. It is a solitary animal; the local people fear it greatly, and flee from it as it does from them.

Flacourt could have been describing *Megaladapis,* the

Bocourt et Faguet pinx.[t]

Imp. Becquet à Paris.

Indri indri

Keulemans pinx.t Imp. Becquet fr. Paris.

Lemur mongoz coronatus

largest of the extinct lemurs, which was about the size of a full-grown St. Bernard. *Megaladapis* remains are common in areas near Fort-Dauphin.

Legends also abound about the living lemurs. In some cases these have even contributed to the animals' survival. *Indri,* for instance, the largest of today's lemurs and now found only in a restricted area of the eastern rain forest, is protected by a taboo that prohibits killing it. This taboo stems from a folk belief that *Indri,* known locally as *babakoto,* and humans are descended from the same ancestors. In one version of the legend, a man and woman lived in the forest, where they spent their days searching for food. To this couple were born many children, who all lived on the wild produce of the forest. Presently some of the children began to clear the land and grow rice, while others, less industrious, continued to live on the bounty of nature. The rice-growers became the ancestors of man, while the others became *babakotos.* Since the latter were the brothers of men, killing them was forbidden.

Another folktale suggests that the attempt to kill a *babakoto* is in itself hazardous. The Malagasy say that if a spear is thrown at one of these animals, it will catch the weapon and throw it back with great force and deadly accuracy. Incidentally, this lemur derived its scientific name, *Indri indri,* from an incident involving the eighteenth-century French explorer Sonnerat, whose excited Malagasy guides pointed at the animal, shouting "indri, indri!" Sonnerat later wrote, "In the Malagasy language, indri means 'man of the woods.' " In fact, *babakoto* means "man of the woods"; *indri* means "look at that!"

Propithecus, a close relative of *Indri,* and commonly known as the sifaka, is another lemur that once was, and in some areas still is, protected by local beliefs and laws. Grandidier himself records an incident involving the sifaka that took place during his journey through the south of Madagascar in 1866. Grandidier had just shot a sifaka of a species then new to science and had set about preparing the animal to preserve its skin and skeleton. For reasons not clearly understood by him, this event started a great commotion among the local populace, and before long a deputation of indignant Malagasy villagers arrived on the scene to protest. Eventually they allowed him to take the material he wanted, but insisted that, in compliance with an edict of their king, he must return the animal's flesh to them. This Grandidier did. The remains were then buried with much ceremony, and the grave covered with spiny cactus to prevent its desecration.

Taboos do not always work in the lemur's favor. *Daubentonia,* the aye-aye, strangest of all the lemurs, has been reduced to near-extinction with considerable help from local beliefs. Although some Malagasy reportedly believed that anyone who harmed an aye-aye would die within a year, nowadays it is more likely that an aye-aye will be killed on sight, since the animal is thought to be evil. A French engineer based at Maroantsetra, in a region where a few aye-ayes still survive, told me that twice in six months he had seen dead aye-ayes by the road, killed by local people.

In many areas, however, beliefs, which might have once protected lemurs, are no longer effective. They are hunted indiscriminately and the destruction of their habitat continues unabated, despite present-day conservation efforts. If these practices continue unchecked, in a century's time the entire prosimian fauna along with the remaining forests of Madagascar will be no more than memories.

Ten years ago, the naturalist David Attenborough studied the activities of sifakas in *Didierea* forests near the village of Ifotaka in the south of Madagascar. *Didierea,* a tree unique to this part of the island, is similar to the familiar saguaro cactus of the southwestern United States. Its slender pillars, covered with spirals of sharp spines and small, bright-green leaves, rise to heights of more than thirty feet. Sifakas, perhaps the most beautiful of all the lemurs, cling to, and leap great spans between, the *Didierea.* That any animal should leap between these spiny trunks seems incredible, but the sifakas do, and apparently with no ill effects. Unfortunately, the *Didierea* forests are as vulnerable to fire as the other forests of Madagascar. Today the land around Ifotaka is barren: the forest has vanished, and the lemurs with it.

The Malagasy prosimians hold a special interest not only for zoologists but for anthropologists as well. These animals represent an evolutionary stage approximating one through which the ancestors of the higher primates passed at a remote point in their evolution. And, while lemurs have diversified enormously, they are basically similar to the prosimians that were widespread throughout the world when lemur ancestors first began to populate Madagascar.

Studies of lemur social organization and behavior have provided valuable clues to the evolution of the social life of higher primates. Recently, a researcher working with two distantly related living species, the sifaka and the maki, *Lemur catta,* found essential similarities in social organization between the two. What's more, this study demonstrated the continuity in basic primate social patterns between the "unintelligent" prosimians and the "intelligent" higher primates.

Social organization among the higher primates is extremely variable, but there are certain recurrent patterns. They tend to live in relatively stable groups, comprised of individuals of all ages and both sexes, that inhabit well-defined home ranges. Cohesiveness in these groups is maintained largely by the interaction between infants and adults, and by the grooming, bodily contact, and play among the group's members. All these elements are present in the social groupings of both sifakas and makis, even though the life experience of these two animals is quite different.

A young maki, for instance, is born into a troop of perhaps 15 to 25 individuals. Within this group there is a fairly strict dominance order in which the young animal must find its place. This pattern of dominance is revealed in the troop's composition as it moves from one part of the forest to another: the females, juveniles, and dominant adult males move in the fore, while the subordinate males bring up the rear. Dominance in this context is often established by one animal's triumph over another in an aggressive dispute, and the life of a

male maki is apt to be one long round of these confrontations.

By comparison, the life of a sifaka is far more peaceful. Within the sifaka troop, usually no more than half a dozen animals, few aggressive disputes take place, although fighting does occur during the short breeding season. There is no apparent dominance hierarchy, and almost any individual can initiate group movement or lead the troop as it moves through the trees.

These two lemurs, then, share with the higher primates a stable and heterogeneous troop structure. They also live in distinct home ranges. The sifaka's energetic defense of its territory and the maki's more relaxed attitude shadow almost exactly the range of tolerances shown to neighboring troops by various kinds of monkeys and apes. Mutual grooming, too, reinforces bonds within the lemur social unit, just as in monkey groups. But while monkeys and apes groom each others' fur by using their fingers, lemurs use their teeth. In fact, the front teeth of almost all modern lemur species are modified specifically for this purpose, and the existence of so specialized a grooming instrument emphasizes the importance of this behavior pattern to the maintenance of group cohesiveness.

As in monkeys and apes, the young of these lemurs, particularly the newborn, form a focus of group attention, while play, among adults as much as among juveniles, constitutes a substantial part of their social behavior and acts as another cement for social bonds.

Yet lemurs are, by almost any standard, less "intelligent" than higher primates. Their brains are neither as large nor as well developed as those of monkeys. Nor do they perform as well as monkeys in laboratory tests. Not only do they tend to show less interest in the kinds of problems presented to them but also, and more importantly, they demonstrate a lesser ability for learning about objects. Their capacity for transferring the experience gained in the solution of one problem to the solution of another is extremely limited.

But in many ways it is unfair to subject nonhuman primates to anthropomorphic tests administered in the laboratory. An animal that fails to solve an apparently simple laboratory problem will have no difficulty in adapting to highly complex social situations in the society of his peers. Perhaps a better way of comparing the intelligence of lemurs and monkeys would be to contrast the complexity of the societies and social interactions within the two groups, although this kind of evaluation entails considerable subjective judgment and also lacks quantitative supporting data. Even so, it is difficult to avoid the conclusion that the range of subtle actions and innovative behavior within the social context is substantially greater among higher primates than prosimians.

On the other hand, it is obvious that the basic patterns of higher primate society exist among diurnal lemurs like the sifaka and maki, and equally obvious that these patterns evolved in the absence of the manipulative and object-learning skills characteristic of monkeys. Since the dependence on the social group among lemurs and monkeys both necessitates and makes possible social learning, it seems likely that a characteristically primate form of society preceded, facilitated, and directed the evolution of primate-type intelligence. If so, it seems reasonable to suggest that the precursors of all the higher primates, including man, possessed patterns of social organization of essentially primate type as far back as the early part of the Eocene epoch, some 55 million years ago. If the nocturnal and relatively nongregarious prosimians that now survive in places other than Madagascar were the only specimens available for study, we would be far less sure about this. We might not even suspect it.

It is really not surprising that a good deal can be learned about the earliest stages of our own evolution by studying living lemurs. More remarkable is that support for a recent hypothesis about the origins of our own zoological family, Hominidae, comes from the study of the extinct lemur *Hadropithecus.* To understand this, however, first requires some knowledge of the criteria that are considered in attempts to explain how human ancestors evolved.

Man differs in numerous ways from his closest living relatives, the apes. Many of the most striking differences, however, are more or less recent developments in our evolution. Our large brain, once considered the diagnostic hominid criterion, is one of these. Our upright posture and striding gait are probably others, although in the absence of fossil evidence, no one can be sure.

Dark areas represent the remaining natural vegetation of Madagascar, ranging from shrub and a few isolated stands of deciduous trees on the dry western side to rain forest on the humid eastern side. Secondary growth (striped areas) attracts few lemurs.

But the characteristics of our masticatory apparatus, including the teeth, are ancient heritages that can be traced back to the earliest hominids of which we have any knowledge. In fact, these are the very characteristics by which we recognize these early ancestors, since jaws and teeth are the most frequently preserved remains and actually constitute the entire hominid fossil record prior to about four million years ago.

The chief differences between the hominid and pongid (ape) chewing apparatuses are the following: the hominid face is generally deeper from top to bottom and is much shorter from front to back; the masticatory muscles are, in correlation with this, shifted forward. The front teeth are greatly reduced in man and his forerunners, while the molars and premolars are broad and flat and shortened from front to back.

These dental differences are even more pronounced in certain early hominids than in modern man. Some of these characteristics are accentuated during an individual's life because of the ways in which the teeth are used. Flat, horizontal wear on the teeth of hominids, for instance, has resulted from the typical grinding mode of chewing.

The earliest known fossil that has these features, and can reasonably be called a hominid, is *Ramapithecus.* This animal has been found primarily in Kenya and northern India, in deposits ranging from 14 million to about 10 million years old. *Australopithecus,* which lived in Africa from about 5 million to about 1 million years ago, presumably descended from *Ramapithecus* or a close relative. Even though there are several species of *Australopithecus,* and a great deal of morphological variation between them, they all show the typical hominid dental-facial complex. Later archaic hominids had teeth virtually identical to our own, and these early men are classified in our own genus, *Homo.*

At some point in the past, a crucial change occurred in the way hominid ancestors lived, a change that was to set them on an evolutionary course divergent from that of the apes. The nature of this change has long been a much debated question. The most convincing explanation is based on an analogy with a living baboon of Ethiopia, *Theropithecus,* the gelada, and can be further strengthened by comparison with the extinct lemur *Hadropithecus.*

For a baboon, the gelada's chewing equipment is relatively hominidlike, although its canines are larger than hominid canines. In the case of the gelada's extinct relatives, however, the canines were considerably smaller than the formidable fangs that make the yawns of most living baboons so startling. Both living and fossil geladas all have tiny incisors and expanded, flattened molars. Compared to the almost doglike snouts of other baboons, the gelada's face is shorter from front to back, and is deepened, with the chewing muscles shifted forward on its skull.

It is essential to the "hominid crucial change" hypothesis that all these gelada features must be related to the animal's feeding habits. Other baboons tend to be generalized browsers, but the gelada exists on a diet of small, tough, gritty morsels found on the ground. When foraging, it squats on the ground, explores the grass with its fingers, and brings food to its mouth with its hands. (Geladas, incidentally, live in the treeless High Semyen of their Ethiopian homeland, and may be the most terrestrial of all nonhuman primates.) The gelada's small incisor teeth are scarcely used in feeding, but its high-crowned and expanded molars have apparently evolved in response to its tough and abrasive diet.

In view of these dental-facial similarities between the gelada and the early hominids, so the hypothesis goes, it seems quite possible that the initial evolutionary shift of the hominids away from the apes was due to a similar dietary specialization. It is at this point that the lemur *Hadropithecus* helps to fill the gap between the gelada and the earliest representatives of man's family tree.

The gelada, for all its usefulness in engendering the hypothesis, is still a baboon; its face is still too snouty and its canines too large for it to provide a good example of an early hominid portrait. *Hadropithecus* comes closer because it had the shortest face of any nonhominid primate, and due to its greatly reduced canine teeth, its yawn was probably not startling at all. It had every other hallmark of the small, tough object feeding pattern as well.

The reduction of this lemur's canines is particularly interesting, since many anthropologists have believed that the reduction of the canines in man came about when the forelimbs were freed from a locomotor function and used to wield weapons and implements. But *Hadropithecus,* clearly a typical lemur in all but its chewing adaptations, cannot conceivably have ever used tools. Yet its canines were very small. This would seem to indicate that the human canine more likely assumed its present size and form in order to complement the incisors and make the biting complex at the front of the jaw more efficient.

Hadropithecus goes further in reinforcing the dietary basis of the hominid crucial change hypothesis by suggesting that small, tough object feeding is feasible in a variety of ecological conditions. The gelada's diet is derived from the open, unforested country in which it lives and to which it is well adapted, while the hominid *Ramapithecus* apparently roamed in forests, judging from the deposits in which its fossils have been found. But *Hadropithecus* remains have been recovered from widely scattered deposits representing a range of ecological conditions in Madagascar several thousand years ago.

It is unfortunate that *Hadropithecus* had perished by the time Alfred Grandidier visited Madagascar in the 1860s. Perhaps only a few centuries before, this lemur was still there. How helpful it would be to have illustrations and written descriptions of this animal, like those of the now-extinct dodo recorded by the first Europeans to land on the shores of Réunion and Mauritius. Fossils of *Hadropithecus* are scanty, little more than two skulls and some jaws, teeth, and a few limb bones, so there isn't much to tell us what the rest of the animal looked like. Of its relative size and the fact that it lived on the ground, we can be sure. But the living animal is gone, and the firsthand observations that might have told us so much were never made.

The Red Badge of Rivalry

Without its epaulets, a male redwing can be pushed right out of its territory

by Douglas G. Smith

It is early spring and a male red-winged blackbird perched atop a cattail is delivering his familiar "konc-kee-ree" song during his threat display. His threat is directed to a neighboring male perched high on another cattail. Only a few feet separate them; an imaginary line marks the boundary between their territories.

The moment these males had arrived in the area, during the late winter months when snow and ice still covered much of the marsh, they began delivering their familiar "song-spread" displays. As the ice and snow melted they moved into the marsh, spending increasing amounts of time displaying from the dead stalks of old cattails and the exposed branches of buttonbushes. By displaying from different perches, they had already started to establish those areas of the marsh that, in many cases, would become their breeding territories. These areas, ranging from 1,000 to 10,000 square feet, had to be defended from other males also intent on establishing territories. Eventually, through displays typical of their species, such as the song spread and the "bill-up boundary," the males spaced themselves out over the entire marsh and the definitions of the territorial boundaries started to come into focus.

Because threats replace fights as a means of settling a territorial dispute and determining the victor, physical harm is not involved. As a general rule, a male is dominant within the boundaries of his own territory, but the moment he enters another male's territory he quickly loses that status.

Since the redwing male must have a territory if he is to secure one or more mates, males with territories are constantly challenged by males without territories. Challengers sometimes, although infrequently, succeed in their attempts to displace an already established male. In response to this constant pressure from intruders, males with territories advertise their presence throughout the breeding season. These displays repel would-be intruders at a distance, thus reducing the number of close-range individual encounters. As the breeding season progresses, the territorial boundaries become well defined and rigid. The frequency of trespasses by neighboring males diminishes, but the threat from nonterritorial males attempting to establish territories is still quite real.

Many species of birds establish and maintain territories in a similar fashion, although the forms of the actual displays vary widely. Other species of birds use different means to establish territories. Variations in the ways that species establish territories are adapted to the type of habitat in which they live, among other factors. Some songbirds, for instance, communicate their whereabouts, personal identity, and threats by vocalizations, rather than by elaborate displays. The wood warblers are good examples. They generally inhabit areas of dense shrubbery or forest where they are more easily heard than seen by conspecifics. In this case, vocalizations are a more efficient way of communicating. Also, predators probably find it more difficult to locate the warblers from their vocalizations. Although many of the warblers appear to be brightly colored when seen in museum cases, in their natural habitat their coloration can be cryptic.

Some birds utilize visual modes of communication. The bowerbirds and the birds of paradise are good examples of such species. When courting, some bowerbirds build elaborate bowers and line the entrance with brightly colored objects, such as bones, shells, and in areas near human habitation, even pieces of aluminum foil. In the birds of paradise, brilliant colors and long plumes have coevolved with extremely elaborate movements, and the result is something that rivals the display of a peacock.

Species of birds with polygamous or promiscuous mating systems tend to have more conspicuous plumage and displays than monogamous species. (In polygamous species, males pair and mate with more than one female; in promiscuous species, males mate with more than

Flaunting his epaulets and giving full cry, a male redwing proclaims his territory to the world.

one female but do not form pairs.) In both polygamous and promiscuous mating systems the male mates with more than one female; therefore some males do not have a chance to breed. The nonbreeders are known as "peripheral males." Since most of the breeding is done by only a few males, there is intense competition for females and, therefore, more selective pressure for the evolution of bright and bizarre plumage to aid the males in their battle for "the right to breed."

In many monogamous species, some of which mate for life, there is much less of a selective premium on bright colors. In fact, there will be selective pressure—in the form of predation—against bright coloration on the male, especially if he assists in caring for the young. For example, migratory geese are monogamous and mate for life; in this species, both sexes are similar in color.

The promiscuous cock-of-the rock, on the other hand, is brightly colored. The females of most species tend to be cryptically colored. But in species such as the phalaropes, where the sex roles are reversed, where the female establishes and maintains a territory while the male incubates the eggs, the female is brightly colored.

To explain this difference in secondary sexual characteristics between males and females, Darwin, in 1871, suggested, in *Descent of Man and Selection in Relation to Sex*, that sexual selection was the selective force responsible. He stated that there were essentially two groups of sexual characteristics that aid one sex in acquiring mates and, therefore, in reproducing.

The antlers, large canines, and other weaponry found on the males of many species of mammals are often disproportionately large when

compared to those of the females. According to Darwin's theory, these characters evolved under the intrasexual selective pressure that resulted from male-to-male combat for a dominant mating position. In other words, those males with more effective weaponry are more frequently able to breed. This sexual selection pressure, therefore, acts to enlarge the secondary sexual characters that permit a male to establish himself as the dominant male, and thereby gives him a higher probability of mating.

Darwin further theorized that the bright and sometimes bizarre plumage of male birds was the result of female choice, or intersexual, selection pressure. In essence, the bright colors and patterns of males provide sexual stimulation for the females, which then choose the male they will mate with on the basis of his colors. Thus, female choice per se provides a selection pressure favoring the evolution of bizarre plumage and brighter markings. Other selective pressures, such as predation, may tend to limit the extent of such conspicuous coloration. An equilibrium results from the interplay of two such forces. If plumage were to become too conspicuous (or unwieldy), the male would be more vulnerable to predators; yet the male, in order to mate, has to provide sufficient sexual stimulation for the female to choose him or to enable threats to be effective in those species where males use bright colors to intimidate other males.

Most naturalists and ornithologists have assumed that the coloration, postures, and vocalizations used by male birds in their displays stimulate females, and thus are a response to the selective pressure exerted by female choice. But virtually no experimentation on the

A male redwing is about to be caught in a trap as he flies at a decoy male intruding in his territory. Once his epaulets are dyed black, the odds are even that he will lose the territory.

The epaulets of captured redwings were blackened with a dye that did not mat the feathers. In a control group, alcohol was used in place of the dye.

roles of color patterns in birds was undertaken until 1935, when G. K. Noble of The American Museum of Natural History started experimenting on plumage patterns, which he thought might be important in sexual recognition. He found that the moustachelike feather pattern on male yellow-shafted flickers is the pattern used by both the male and the female to discriminate between the sexes. He glued a "moustache" on a mated female, and her mate treated her as though she were an intruding male. Only after Noble recaptured her and removed the moustache did the male recognize her as his mate. I decided to extend this type of experimentation on color patterns to other species.

Despite the prevalence of color patterns in birds, few people have tried to determine what role a particular color pattern might have in the life history of a species. Color patterns could be important in communicating threat, sex, sexual intent, sexual condition, and individual identity, as well as other information. Because of the many possible roles for color patterns, I wanted to find a species that was territorial, locally abundant and easy to observe, at least potentially polygamous, and one in which the male was conspicuously colored.

It was important that the species be polygamous. If a male could mate with more than one female, I reasoned that a change in the size, presence, or absence of a color pattern might influence the number of females that he would be able to attract. I also wanted the male to be territorial; any alteration of a coloration might influence the size of a territory or even ultimately determine whether or not the male maintained or lost his territory.

The red-winged blackbird met these criteria. The male has a clearly defined color pattern, the red epaulet. Redwings are easy to observe in marshy areas, where they breed in abundance. They are polygamous and, depending on where they nest, males will mate with from one to six females. Males defend a well-defined territory.

If the males' red epaulets evolved in response to the female choice type of selection pressure, then we could expect an alteration of color pattern to affect sexual encounters. If the epaulet was smaller than its normal size or even eliminated altogether, it is conceivable that the males, although they might still be able to maintain a territory, would be unable to attract females. On the other hand, if the epaulets evolved in response to intrasexual selection pressure, then a male without red epaulets might be unable to maintain his territory but would, theoretically, still attract females.

Male redwings start to establish territories in early spring by singing and displaying from perches within their territories. Their bill-up boundary display is restricted to the boundaries of the territories, and thus, by noting where the males give this display, it is easy, but time-consuming, to map the territories. A peripheral male may intrude on a resident's territory, but he is generally intimidated by the resident male's displays. Fights, although infrequent, do occur, and the intruder sometimes succeeds in establishing himself as the new resident.

Females arrive shortly after the males have set up territories and begin pairing with males by flying into a male's territory of their choosing and staying for longer and longer periods of time. Eventually the females set up subterritories within the males' territories, lay three or four eggs, and then incubate them. The male seldom assists his females in the feeding of the nestlings, but he does help feed the fledglings after they leave the nest. Only after the young fledge do territory boundaries break down.

Throughout the breeding season the male uses his epaulets in a variety of displays. Some of the more common ones are song spread and the bill-up boundary displays. Each display varies in intensity, and with the exception of a very few, most are directed to both males and females.

It seemed plausible then, that if I were to alter the epaulets of territorial males, a behavioral difference between normal males and epaulet-altered males might show up. I began by completely eliminating the red epaulets. They had to be blackened without fouling the feathers. Dye had been used successfully in marking ground squirrels, so at a colleague's suggestion I tried dye on the feathers. When applied, it turned the red feathers black, but they were otherwise unchanged.

Many territorial males had to be captured and their feathers dyed so that any statement about the role of the epaulets would hold up statistically. Because I needed to know the identity of each male and the location of his territory, I had to catch him on his territory and color band him so that he could be recognized in the future. I developed a trap, a rectangular cage in which I placed a male redwing. The catching mechanism was mounted on top of the cage and consisted of a spring-loaded rope net, which would be released when a treadle was moved. The whole trap, with the decoy male in the cage, was then placed within the boundaries of a resident male's territory. In effect, the trap constituted an intruding male. The resident redwing would fly over to the trap and display, thereby tripping the treadle.

Once caught, the male was treated with black dye. A control group was treated in essentially the same way except that alcohol was substituted for the dye. Eighty-seven males were treated; approximately half were experimental and half were controls. After the treatment, all the males were released, and they flew back to their territories where they resumed normal activities.

Of the black-epauleted males more than half lost their territories to intruding males. In contrast, less than 10 percent of the controls lost their territories. This indicates that the epaulets contribute significantly to the communication of threat between rival males. Without the threatening effect of the epaulets, the black-epauleted males were at a disadvantage in maintaining their territories.

An interesting case arose early in this study before I had learned about black dye. I was using fast-drying black enamel to eliminate the red epaulets. To reduce the inevitable sticking together of the feathers, I clipped the red tips of the epaulet feathers, exposing the

lower white parts. Male number 215 held a territory along the edge of a cattail-bordered pond, bordering the territories of two neighboring males. After clipping back his epaulets, I treated 215 with black enamel and released him on his territory. Within two days he had lost his territory to the two neighboring males. Both had extended their boundaries and divided 215's territory about equally between them.

These neighboring males held this additional area for about one week. After that, 215 was back near his territory displaying—with white epaulets! He had preened all the black enamel off his feathers. Within only two days of his return, he had retaken his territory by displaying, forcing the two males back to their original territories and re-establishing his old boundaries. The white epaulets had apparently enabled him to retake and maintain his territory.

Most of the males had already paired with females when they were dyed. After treatment the females did not show any difference in behavior toward either normal or black-epauleted males. The epaulets of a few males had been blackened before the females arrived and, in spite of the lack of red epaulets, some of these black-epauleted males maintained territories throughout the breeding season. Those that did, all mated successfully. This result indicates that the females choose a male on the basis of his territory and not on the basis of his bright coloration.

Some redwing territories are more coveted than others. "Desirable" territories have good nesting sites (vegetation strong enough to support nests and offer protection) and produce large amounts of food per unit area. Marsh-breeding redwings generally feed hatching insects (mostly aquatic) to their young, and so territories with large amounts of vegetation not only have more surface on which the insects can emerge but also provide more foraging area for the redwings.

Of the all-black males that did maintain territories throughout the breeding season, most held less desirable territories composed of buttonbushes with few cattails. Per unit area these buttonbush territories provide less food than do the denser cattail territories. Males maintaining these poorer territories suffered fewer intrusions from rival males than did the males maintaining cattail territories. Intruding males appear to discriminate between territories of different desirableness and to spend more time and energy trying to displace males in possession of better territories. There is an obvious selective value in the male's ability to make these discriminations because with a better territory, a male is more likely to be chosen by a female and, therefore, to reproduce. The territory he selects becomes the secondary sexual characteristic on which the females base their choice of mates.

The male redwing combines vocalizations, movements, and the epaulets to varying degrees in his displays. Because the epaulet is only one component of his display complex, it is not surprising that only half the black-epauleted males lost territories. If males were deprived of their vocalizations as well as their epaulets, they might be more likely to lose an already established territory.

It appears, then, that the epaulets of the male redwing have evolved in response to intrasexual selection pressure, that is, selection for males capable of effectively intimidating other males. They do not seem to have an important function in encounters with females. Because females probably choose a male's territory instead of the male himself, the female choice type of sexual selection pressure has been less important than intrasexual selection pressure in the evolution of red epaulets.

A female redwing listens to the call of a male. Females already paired with males continued to accept them even after their epaulets had been covered with black dye.

Devils, Witches, and Sudden Death

In the hellish mines of Bolivia, workers call upon strange companions to ease their terror

by June Nash

Tin miners in the high Andean plateau of Bolivia earn less than a dollar a day when, to use their phrase, they "bury themselves alive in the bowels of the earth." The mine shafts—as much as two miles long and half a mile deep—penetrate hills that have been exploited for more than 450 years. The miners descend to the work areas in open hauls; some stand on the roof and cling to the swaying cable as the winch lowers them deep into the mine.

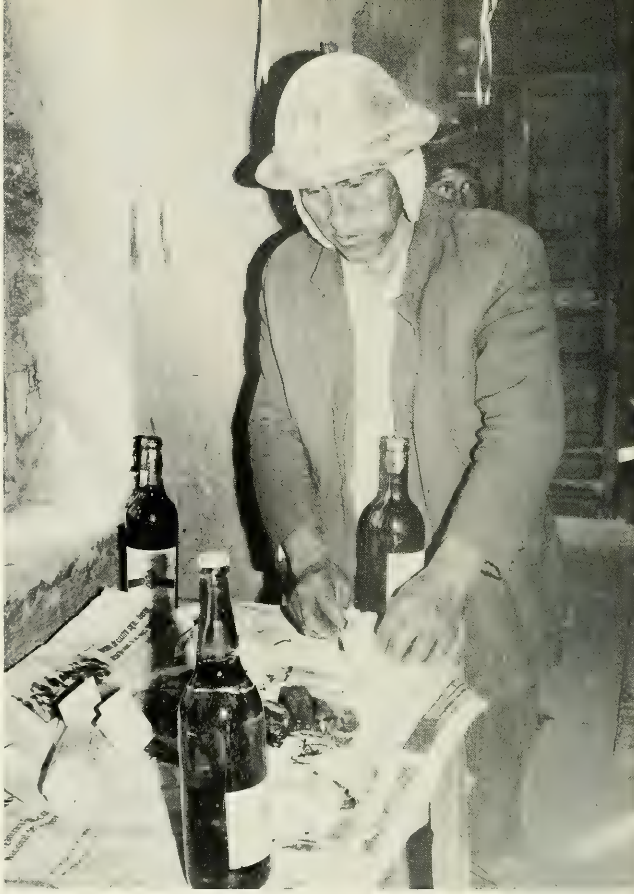
Once they reach their working level, there is always the fear of rockslides as they drill the face of the mine, of landslides when they set off the dynamite, of gas when they enter unfrequented areas. And added to their fear of the accidents that have killed or maimed so many of their workmates is their economic insecurity. Like Wall Street brokers they watch international price quotations on tin, because a difference of a few cents can mean layoffs, loss of bonuses, a cut in contract prices—even a change of government.

Working in the narrow chimneys and corridors of the mine, breathing the dust- and silicate-filled air, their bodies numbed by the vibration of the drilling machines and the din of dynamite blasts, the tin miners have found an ally in the devil, or Tio (uncle), as he is affectionately known. Myths relate the devil to his pre-Christian counterpart Huari, the powerful ogre who owns the treasures of the hills. In Oruro, a 13,800-foot-high mining center in the western Andes of Bolivia, all the miners know the legend of Huari, who persuaded the simple farmers of the Uru Uru tribe to leave their work in the fields and enter the caves to find the riches he had in store. The farmers, supported by their ill-gained wealth from the mines, turned from a virtuous life of tilling the soil and praying to the sun god Inti to a life of drinking and midnight revels. The community would have died, the legend relates, if an Inca maiden, Nusta, had not descended from the sky and taught the people to live in harmony and industry.

Despite four centuries of prose-

At a graveside service, the family, friends, and fellow workers of a Bolivian miner mourn his death.

In a mine, a worker offers liquor, coca, and cigarettes to the Tio. "We do not worship him. We do not kneel before him," said one miner.



lyting, Catholic priests have failed to wipe out belief in the legend, but the principal characters have merged with Catholic deities. Nusta is identified with the Virgin of the Mineshaft, and is represented as the vision that appeared miraculously to an unemployed miner.

The miners believe that Huari lives on in the hills where the mines are located, and they venerate him in the form of the devil, or Tio. They believe he controls the rich veins of ore, revealing them only to those who give him offerings. If they offend the Tio or slight him by failing to give him offerings, he will withhold the rich veins or cause an accident.

Miners make images of the Tio and set them up in the main corridors of each mine level, in niches cut into the walls for the workers to rest. The image of the Tio varies in appearance according to the fancy of the miner who makes him, but his body is always shaped from ore. The hands, face, horns, and legs are sculptured with clay from the mine. Bright pieces of metal or burned-out bulbs from the miners' electric torches are stuck in the eye sockets. Teeth are made of glass or crystal sharpened "like nails," and the mouth is open, gluttonous and ready to receive offerings. Sometimes the plaster of Paris masks worn by the devil dancers at Carnival are used for the head. Some Tios wear embroidered vests, flamboyant capes, and miners' boots. The figure of a bull, which helps miners in contract with the devil by digging out the ore with its horns, occasionally accompanies the image, or there may be *chinas*, female temptresses who are the devil's consorts.

The Tio is a figure of power: he has what everyone wants, in excess. Coca remains lie in his greedy mouth. His hands are stretched out, grasping the bottles of alcohol he is offered. His nose is burned black by the cigarettes he smokes down to the nub. If a Tio is knocked out of his niche by an extra charge of dynamite and survives, the miners consider him to be more powerful than others.

Another spirit present in the mines but rarely represented in images is the Awiche, or old woman. Although some miners deny she is the Pachamama, the earth goddess worshiped by farmers, they relate to her in the same way. Many of the miners greet her when they enter the mine, saying, "Good-day, old woman. Don't let anything happen to me today!" They ask her to intercede with the Tio when they feel in danger; when they leave the mine safely, they thank her for their life.

Quite the opposite kind of feminine image, the Viuda, or widow, appears to miners who have been drinking *chicha*, a fermented corn liquor. Miners who have seen the Viuda describe her as a young and beautiful *chola*, or urbanized Indian, who makes men lose their minds—and sometimes their paychecks. She, too, is a consort of the devil and recruits men to make contracts with him, deluding them with promises of wealth.

When I started working in Oruro during the summer of 1969, the men told me about the *ch'alla*, a ceremonial offering of cigarettes, coca, and alcohol to the Tio. One man described it as follows:

"We make the *ch'alla* in the working areas within the mine. My partner and I do it together every Friday, but on the first Friday of

the month we do it with the other workers on our level. We bring in banners, confetti, and paper streamers. First we put a cigarette in the mouth of the Tio and light it. After this we scatter alcohol on the ground for the Pachamama, then give some to the Tio. Next we take out our coca and begin to chew, and we also smoke. We serve liquor from the bottles each of us brings in. We light the Tio's cigarette, saying 'Tio, help us in our work. Don't let any accidents happen.' We do not kneel before him as we would before a saint, because that would be sacrilegious.

"Then everyone begins to get drunk. We begin to talk about our work, about the sacrifices that we make. When this is finished, we wind the streamers around the neck of the Tio. We prepare our *mesas* [tables of offerings that include sugar cakes, llama embryos, colored wool, rice, and candy balls].

"After some time we say, 'Let's go.' Some have to carry out those who are drunk. We go to where we change our clothes, and when we come out we again make the offering of liquor, banners, and we wrap the streamers around each others' necks. From there on, each one does what he pleases."

I thought I would never be able to participate in a *ch'alla* because the mine managers told me the men didn't like to have women inside the mine, let alone join them in their most sacred rites. Finally a friend high in the governmental bureaucracy gave me permission to go into the mine. Once down on the lowest level of San José mine, 340 meters below the ground, I asked my guide if I could stay with one of the work crews rather than tour the galleries as most visitors did. He was relieved to leave me and get back to work. The men let me try their machines so that I could get a sense of what it was like to hold a 160-pound machine vibrating in a yard-wide tunnel, or to use a mechanical shovel in a gallery where the temperature was 100° F.

They told me of some of their frustrations—not getting enough air pumped in to make the machines work at more than 20 percent efficiency and constant breakdowns of machinery, which slowed them up on their contract.

At noon I refused the superintendent's invitation to eat lunch at level O. Each of the men gave me a bit of his soup or some "seconds," solid food consisting of noodles, potatoes, rice, and spicy meat, which their wives prepare and send down in the elevators.

At the end of the shift all the men in the work group gathered at the Tio's niche in the large corridor. It was the first Friday of the month and the gang leader, Lino Pino, pulled out a bottle of fruit juice and liquor, which his wife had prepared, and each of the men brought out his plastic bag with coca. Lino led the men in offering a cigarette to the Tio, lighting it, and then shaking the liquor on the ground and calling for life, "Hallalla! Hallalla!"

We sat on lumps of ore along the rail lines and Lino's helper served us, in order of seating, from a little tin cup. I was not given any priority, nor was I forgotten in the rounds. One of the men gave me coca from his supply and I received it with two hands, as I had been taught in the rituals aboveground. I

When they toast the Tio, Indian workers often ask him to "produce" minerals and let them "ripen," as if the ore were a farm crop.

chewed enough to make my cheek feel numb, as though I had had an injection of novocaine for dental work. The men told me that coca was their gift from the Pachamama, who took pity on them in their work.

As Lino offered liquor to the Tio, he asked him to "produce" more mineral and make it "ripen," as though it were a crop. These rituals are a continuation of agricultural ceremonies still practiced by the farmers in the area. The miners themselves are the sons or grandsons of the landless farmers who were recruited when the gold and silver mines were reopened for tin production after the turn of the century.

A month after I visited level 340, three miners died in an explosion there when a charge of dynamite fell down a shoot to their work site and exploded. Two of the men died in the mine; the third died a few days later in the hospital. When the accident occurred, all the men rushed to the elevators to help or to stare in fascinated horror as the dead and injured were brought up to level 0. They carried the bodies of their dead comrades to the social center where they washed the charred faces, trying to lessen the horror for the women who were coming. When the women came into the social center where the bodies were laid out, they screamed and stamped their feet, the horror of seeing their husbands or neighbors sweeping through their bodies.

The entire community came to sit in at the wake, eating and drinking in the feasting that took place before the coffins of their dead comrades. The meal seemed to confirm the need to go on living as well as the right to live.

Although the accident had not occurred in the same corridor I had been in, it was at the same level. Shortly after that, when a student who worked with me requested permission to visit the mine, the manager told her that the men were hinting that the accident had happened because the gringa (any foreign-born, fair-haired person, in this case myself) had been inside. She was refused permission. I was disturbed by what might happen to my relations with the people of the community, but even more concerned that I had added to their sense of living in a hostile world where anything new was a threat.

The miners were in a state of uneasiness and tension the rest of that month, July. They said the Tio was "eating them" because he hadn't had an offering of food. The dead men were all young, and the Tio prefers the juicy flesh and blood of the young, not the tired blood of the sick older workers. He wanted a *k'araku*, a ceremonial banquet of sacrificed animals.

There had not been any scheduled *k'arakus* since the army put the mines under military control in 1965. During the first half of the century, when the "tin barons"—Patiño, Hochschild, and Arayamao—owned the mines, the administrators and even some of the owners, especially Patiño, who had risen from the ranks, would join with the men in sacrificing animals to the Tio and in the drinking and dancing that followed. After nationalization of the mines in 1952, the rituals continued. In fact, some of the miners complained that they were done in excess of the Tio's needs. One said that going into the mine after the revolution was like walking into a saloon.

Following military control, however, the miners had held the ritual only once in San José, after two men had died while working their shift. Now the Tio had again shown he was hungry by eating the three miners who had died in the accident. The miners were determined to offer him food in a *k'araku*.

At 10:30 P.M. on the eve of the devil's month, I went to the mine with Doris Widerkehr, a student, and Eduardo Ibañez, a Bolivian artist. I was somewhat concerned about how we would be received after what the manager of the mine had said, but all the men seemed glad we had come. As we sat at the entry to the main shaft waiting for the *yatiris*, shamans who had been contracted for the ceremony, the miners offered us *chicha* and cocktails of fruit juice and alcohol.

When I asked one of the men why they had prepared the ritual and what it meant, his answer was:

"We are having the *k'araku* because a man can't die just like that. We invited the administrators, but none of them have come. This is because only the workers feel the death of their comrades.

"We invite the Pachamama, the Tio, and God to eat the llamas that we will sacrifice. With faith we give coca and alcohol to the Tio. We are more believers in God here than in Germany or the United States because there the workers have lost their soul. We do not have earthquakes because of our faith before God. We hold the crucifix to our breast. We have more confidence before God."

Most miners reject the claim that belief in the Tio is pagan sacrilege. They feel that no contradiction exists, since time and place for offerings to the devil are clearly defined and separated from Christian ritual.

At 11:00 P.M. two white llamas contributed by the administration were brought into level 0 in a company truck. The miners had already adorned the pair, a male and a female, with colored paper streamers and the bright wool earrings with which farmers decorate their flocks.

The four *yatiris* contracted for did not appear, but two others who happened to be staying at the house of a miner were brought in to perform the ceremony. As soon as they arrived, the miners took the llamas into the elevator. The male was on the right and the female to his left, "just the same as a marriage ceremony," one miner commented. Looking at the couple adorned with bright streamers and confetti, there was the feeling of a wedding.

Two men entered the elevator with the llamas and eight more climbed on top to go down to level 340. They were commissioned to take charge of the ritual. All the

A model of the Tio, shaped by the workers, sits in a mine alcove. If the image survives an explosion, it is considered very powerful.

Pushing a cart, workers with puffed cheeks chew coca, a narcotic. Falling rocks are a constant danger in the narrow corridors, lower left.

workers of 340 entered to participate in the ceremony below and about 50 men gathered at level O to drink.

At level 340 the workers guided the *yatiris* to the spot where the accident had occurred. There they cast liquor from a bottle and called upon the Tio, the Awiche, and God to protect the men from further accidents—naming all the levels in the mine, the various work sites, the different veins of ore, the elevator shaft, and the winch, repeating each name three times and asking the Tio not to eat any more workers and to give them more veins to work. The miners removed their helmets during this ritual. It ended with the plea for life, "Hallalla, hallalla, hallalla." Two bottles of liquor were sprinkled on the face of the rock and in the various work places.

The *yatiris* then instructed the men to approach the llamas with their arms behind their backs so that the animals would not know who held the knife that would kill them. They were also told to beg pardon for the sacrifice and to kiss the llamas farewell. One miner, noting what appeared to be a tear falling from the female's eye, cried and tried to comfort her. As the men moved around the llamas in a circle, the *yatiris* called on the Malkus (eagle gods), the Awiche, the Pachamama, and finally the Tiyulas

Continued on page 82

After two men died in an explosion, the miners held a *k'araku*, an ancient ceremony that included the sacrifice of two llamas.

Predators of the Serengeti: Part 2

Are You Running with Me, Hominid?

With different hunting patterns, each large carnivore fills a special niche. Early man was once there, too

by George B. Schaller

At times during my three-year study in the Serengeti, especially as I walked alone across the plains with the dry grass rustling beneath my feet and columns of wildebeest streaming under the hazy sky, a consciousness of the past would fill me. I would climb on a kopje—those wind-worn granite islands that jut from the plains—and imagine that I was an early hominid, squinting into the glare, watching for descending vultures as a sign of meat to scavenge. What sort of life, I wondered, did these ancient relatives of man have, existing both as hunter and hunted?

The leopard often carries its kill into a tree because other predators, particularly the lion, may steal it on the ground.

During the many times I watched predators hunt and kill, I had sympathy for the prey, yet I felt a strange tie, an emotional kinship with the predator. Man is by inheritance a primate; by avocation a carnivore. For perhaps two million years he has at least supplemented his diet with meat. As anthropologist Sherwood Washburn noted, "In a very real sense our intellect, interests, emotions, and basic social life—all are evolutionary products of the success of the hunting adaptation."

When trying to deduce the social system used by *Australopithecus* and other early hominids, many anthropologists have looked for clues among nonhuman primates. This is logical on phylogenetic grounds but not on ecological ones. Social systems are so strongly influenced by the ecological conditions under which an animal lives that even the same species may behave differently from area to area. Monkeys and apes are essentially vegetarians, living in groups confined to small ranges. Early man and his precursors, on the other hand, were widely roaming scavengers and hunters, a way of life that has diverged so drastically from the nonhuman primates that any similarities in the social systems of the two may well be accidental.

We can probably learn more about the genesis of man's social system by studying phylogenetically unrelated but ecologically similar forms than by examining nonhuman primates. The social carnivores provide an obvious choice. Some of the selective forces that influenced the social existence of the lion, hyena, and wild dog may also have had an effect on hominid societies.

Less obvious, but also important for an ecological perspective on the evolution of hominids, are the different hunting systems of all the large carnivores, including the leopard, the cheetah, and even the extinct saber-toothed tiger. During their evolutionary histories, each of these animals has competed with hominids for food.

The Leopard: The opposite of the sociable lion, the leopard is the essence of a solitary cat. "Secretive, silent, smooth and supple as a piece of silk," as described by Maitland Edey, "he is an animal of darkness

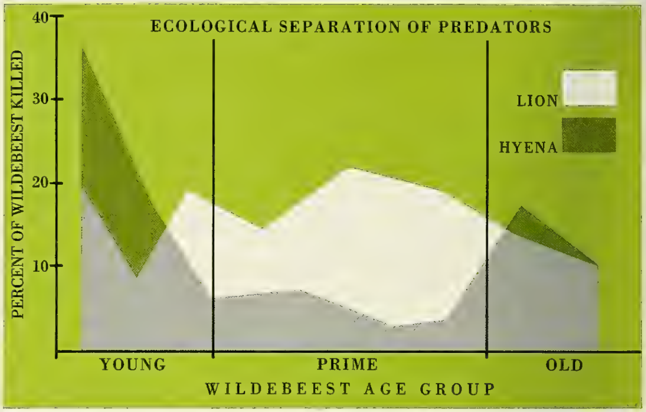
and even in the dark he travels alone."

The Serengeti leopards favor riverine forests, kopjes densely overgrown with scrubs, and the extensive thickets in the northern part of the park. They are sparse on the plains.

In my study, I found that the ranges of resident leopards overlapped considerably, although each animal tended to focus its activity in an area little used by others at the time. Two adults were occasionally within a quarter-mile of each other, and during one period three females and a subadult male hunted along the same three-mile stretch of river, yet only once did I see two adults together when they were not courting. This indicates a strong mutual avoidance, probably based both on direct visual contact and on such indirect methods as marking with scent.

We know little about the causes of death among leopards, but several cases of fatal confrontations with lions have been reported. On April 3, 1967, visitors came upon eleven lions of the Masai pride as they milled about and pawed a freshly killed female leopard: she had been bitten through the lower back and throat. Park warden Myles Turner gave me the following excerpt from his field notes: "On 17th September, 1960, at 8:00 A.M., the local pride of lions was noted lying under a tree near the Seronera River with a female leopard high in the tree above them, obviously very nervous. . . . The leopard attempted to descend but was promptly chased up again. Suddenly the lions converged on a grass clump and pulled out two small leopard cubs about six weeks old. They were immediately torn to pieces and consumed." The leopard may stay in overgrown habitats not only because of its hunting methods but also because these areas provide a refuge from lions.

The leopard is primarily a night hunter, although I did see nine leopard stalks in the daytime. One of these attempts, at a waterhole, culminated in a successful rush. Other observers told me of six daytime rushes, three of them successful. On one occasion a female



Both lions and hyenas prey extensively on wildebeest in the Serengeti, but they tend to kill different age groups.

stalked a herd of gazelle in the plains and was within 100 feet of it when the gazelle sensed her; but instead of fleeing, they merely snorted and stamped their forelegs. A visitor observed a leopard leap on a warthog but fall off when it lunged ahead and fled. Photographer Simon Trevor watched three adult baboons, in a reversal of roles, chase a leopard from the vicinity of a group along the Seronera River.

The leopard's diet is more varied than that of the lion and cheetah, and food items in the Serengeti include python, several kinds of birds, hare, hyrax, various small and medium-sized antelopes, and a surprising number of other carnivores, a total of 24 species. Any casual list of kills shows a strong bias in favor of large animals, which leopards tend to store in trees. I collected most data on kills around the park headquarters at Seronera and at the edge of the woodlands during dry times. Among the large prey items were Thomson's gazelle, which weigh, at most, 50 pounds; reedbuck, 145 pounds; impala, 140 pounds; and Grant's gazelle, 155 pounds. Other prey consisted of small species or the young of large ones. Leopards seem to prefer prey in the 40- to 155-pound category, with an upper limit at about 325 pounds, two to three times the weight of the cat itself.

A leopard drags large prey by grasping the animal's neck and straddling the body between forelegs, a position also used to scramble up a tree trunk with a carcass. To wedge a kill into the branches may require several minutes of effort, as the limp body often slips and has to be lifted to another, more secure spot. Such storing of carcasses helps keep them out of reach of jackals and hyenas and usually of lions too. Vultures seldom bother kills in trees.

On one occasion, a leopard immediately hauled its kill 40 feet into a tree when a hyena approached. On three occasions, lions climbed trees and took a kill, but they failed to find it on several others. Once, three lions circled a tree for 15 minutes, sniffing the trunk and seeming to stare directly at the carcass, which was clearly visible in a fork 15 feet above them, but they finally walked off. Another time, an injured and obviously hungry lioness behaved similarly when a reedbuck was hanging a mere 12 feet from her. The lions seemed aware that there was a kill near the tree, but in most instances were apparently unable to recognize the motionless, distorted carcass by sight.

The Cheetah: With its small, round head, deep chest, trim waist, and long slender legs, the cheetah is the least typical of the cats, an animal built for speed rather than power. While cheetah occur throughout the Serengeti ecological unit, they prefer the plains and the

woodlands-plains border. Their distribution in the Serengeti seems to be less influenced by vegetation than by the movements of Thomson's gazelle, their principal prey. Their appearance and disappearance correlate with the gazelle migration.

Several cheetah occupied the same general area around Seronera during the dry season, some as temporary residents, others only as transients. Cheetah merely avoided contact when they saw each other, with no evidence of any form of territorial defense. The animals spaced themselves out by centering their activity in a locality not much used by others at the time and by avoiding meetings by both visual and olfactory means.

In a previous article ("This Gentle & Elegant Cat," NATURAL HISTORY MAGAZINE, June-July, 1970), I described cheetah predation. I found that out of a total of 261 cheetah kills found, 91 percent were Thomson's gazelle, and most of the others were Grant's gazelle, wildebeest, impala, and hare. The prey's size is a major factor in its selection. Thomson's gazelle seldom weigh more than 45 pounds. Among the other kills, all the wildebeest and hartebeest, one Grant's gazelle, and one topi were less than two months old.

Cheetah feed rapidly, stopping occasionally to look around as if nervous, probably because other predators frequently appropriate the kill. In contrast to other predators, cheetah apparently do not scavenge. Being low in the interspecific predator hierarchy, in most instances cheetah are probably too timid to investigate possible sources of meat.

The Hyena: Serengeti hyenas reach their greatest abundance on the plains. Their basic social unit is the clan, which may consist of 10 to 60 or more hyenas of both sexes and all ages. Most hyenas are unable to maintain permanent clan territories in the Serengeti because their preferred prey, wildebeest and zebra, may be many miles from the plains. As the migratory herds retreat to the woodlands, clans on the plains tend to break up. Some animals become nomadic, following the prey. Hyenas from several clans may associate without animosity around a prey concentration and may even establish a temporary clan, which dissolves as food again becomes scarce. With the advent of the dry season, other hyenas, particularly females with cubs, move only to the edge of the woodlands; from there they may commute 20 miles to some prey concentration, feed, and then return to their den.

Hyenas kill 68 percent of their prey and scavenge the rest. Because wildebeest are both vulnerable and rewarding in the amount of meat they provide—one adult feeds an average of 12.6 hyenas—this species is the preferred prey. Hyenas usually hunt at night, merely chasing their quarry. They do not stalk or lie in ambush. A wildebeest herd may permit a hyena to approach to within 20 yards or less before wheeling around and fleeing, tightly bunched. The hyena, in turn, dashes at the herd as if to scatter it; finally one animal may be selected, often a calf if available, and pursued at speeds up to 30 miles per hour. After a chase of one to three miles, the hyena either gives up the attempt or is able to stop the animal by biting its legs or belly.

The decision to hunt zebra is apparently made by a clan before the hunt begins. Animals gather and synchronize their activity by, for example, visiting latrine areas. After that a pack may pass through wildebeest herds until it finds zebra. A zebra herd occasionally permits hyenas to approach to within five yards before it flees or a stallion attacks. The chase is at speeds of 10 to 20 miles per hour, much slower than zebra can run. As with other prey, hyenas tend to select the weakest animals from a herd.

Once they pull an animal down, hyenas rip open the abdomen and bolt first the viscera, then the rest of the meat. Fights seldom erupt in competition over food, although an animal with a bone may be vigorously chased by others. Cubs have no priority at kills except when their mother protects them. Hans Kruuk, the source of most of my information on hyenas, once observed 35 hyenas kill a female zebra and clear all the remains in 36 minutes. The hyena is below the lion in the predator hierarchy, but at times I was surprised at their temerity in attacking lions. One evening I watched two lionesses at a wildebeest kill. Almost imperceptibly, hyenas began to gather nearby in the darkness. They waited silently. By 11:00 P.M. there were 17 of them. The lions started to bolt down meat, possibly anticipating the loss of their kill. As if on signal, the hyenas began to whoop. They circled the lions, drawing ever closer, in an eerie game of psychological warfare. Then they rushed to the kill, and the lions fled into the darkness.

The Wild Dog: Small in size, with a splotchy white, black, and yellow coat, the African wild dog, or hunting dog, does not seem to be the kind of animal that could arouse man's passion to the extent that it has—being relentlessly and irrationally persecuted throughout its range. Wild dogs are scarce in the Serengeti, with months sometimes elapsing between sightings of a pack, which averages ten adult dogs. The animals usually disregard the presence of a vehicle, permitting it to approach to within ten yards or less; sometimes they will even bite the tires or otherwise investigate it. On one occasion, when my car fell into a warthog burrow, a pack stood 15 yards away and watched me dig it out.

Packs with small young remain in the vicinity of a den. The animals leave the den to hunt, but return to it afterward, a pattern that restricts their range of activity. Once the young are mobile, packs travel widely. Ranges overlap extensively, and in a few instances probably completely. While it is possible that packs defend the area immediately around their dens, there is no evidence to suggest that they are territorial at other times. The scarcity of packs alone tends to space animals out, and olfactory cues, such as the animal's powerful body odor, may also help in this respect.

The most striking aspect of dog society is the amity that exists between members. Even when the whole pack is crowded around a kill there is little overt strife; growling and snapping, characteristic among lions, usually do not occur. I never

saw two dogs fight. In competition for a bone or in other potentially eruptive situations, both animals tend to assume the appeasement posture, thereby terminating the interaction.

Packs seem to lack a rigid hierarchy. Males and females share most tasks equally, including hunting and feeding the young, although certain individuals assume special functions. For example, some adults lead in the hunt, while others, especially yearlings, trail behind. The spoils, however, are divided among all members. When pups are at the den, one or more members remain to guard them. The returning hunters then regurgitate meat for the pups, as well as for the guards. On one occasion a lame dog dropped so far behind the pack that there was no meat left when he reached the carcass. He begged from several members and received some.

Once pups accompany the adults on the hunt, they are seldom fed on regurgitated meat. Instead, they take almost complete precedence at a kill. Adults may grab a bite at the time the prey has been caught, but as soon as the pups arrive, adults step back and permit them to monopolize the carcass. Any adult that tries to eat is chased away by the twittering, aggressive young—behavior already evident at the den when large pups bite at the adults' lips and legs while begging for food. The adults stand around the feeding young, forming a protective circle that prevents hyenas and jackals from grabbing the meat. Pups retain their priority for food until they are about eight months old. Considering the high death rate of adults, any factor that contributes to a high survival rate of pups, such as having priority at the kill, has selective advantage.

In some respects the wild dog is an easy subject for the study of predation, for it hunts predictably each day and permits a vehicle to follow it without altering its behavior. I observed the hunting and killing of Thomson's gazelle 37 times, of wildebeest 29 times, and of other prey 21 times. Dogs hunt mainly in the morning and evening. After lying huddled in small groups in the vicinity of the den all night, they generally set off with first light at about 6:00 A.M. The evening hunt, if any, is rarely started before 5:00 P.M. Occasionally, packs hunt on moonlit nights. Setting out on a hunt, the dogs often move in single file but soon spread loosely over the terrain, a useful formation for finding crouched gazelle.

The time a pack spends hunting depends, of course, on the availability of prey. On the whole, the animals are rarely active more than four to five hours a day—traveling, killing, and feeding. Of 48 hunts observed, an average of 30 minutes elapsed from the time a pack left its den or rest area to the first kill. Some hunts were successful within 10 minutes, and all except five were successful within one hour. The dogs consume the edible portions of a Thomson's gazelle within 5 to 10 minutes, although bones are often gnawed clean for several more. The dogs gorge themselves at a large carcass within 15 to 30 minutes.

Hunting dogs may be trailed by one or more hyenas, which later attempt to snatch the kill or at least a morsel of it. The dogs, in turn, may rush at the hyenas, and in the event that these have managed to appropriate some meat, may nip them in the rump until they drop the food, which the dogs then retrieve. When attacked, subadult hyenas often crouch instead of fleeing, and such individuals are at times permitted to feed on the kill. Several hyenas may drive dogs from a carcass, yet the reverse also happens. The interactions between these two predators are highly variable, and probably depend more on the number of animals involved and the extent of their hunger than on any rigid hierarchical relationship. In fact, when not competing for food, dogs and hyenas tolerate each other more than any other two predators, even resting side by side in the shade of the same tree.

The dogs' hunting methods vary with the species of prey. Usually only one or two dogs chase a Thomson's gazelle while others trail. The speed of the chase is about 35 miles per hour. Often sprinting at the beginning of the chase, a gazelle proceeds in a flat gallop as a dog draws closer, and finally, with capture imminent, it zigzags and reverses direction. This tactic causes it to lose speed, and finally the dog grabs it, pulling it down. A bite into the lower abdomen disembowels the quarry, and other dogs usually arrive within seconds and tear it to pieces.

A pursued gazelle may run in a wide semicircle, and at such times the dogs hunt cooperatively. While one or two dogs follow the gazelle, the others cut across the arc and surround the gazelle. Brief relay hunts, with one dog taking the place of another that was chasing, were seen on three occasions. Most pursuits end after a short chase.

When they hunt wildebeest, packs seem to search specifically for small calves. On one occasion several hundred adult wildebeest, yearlings, and large calves galloped in single file while the dogs merely stood and watched them pass. But when a small calf, born late in the season, ran past, it was immediately pursued and killed. Dogs often bunch up and walk toward a herd in a stalk before suddenly dashing when less than 100 yards from it. Wildebeest draw together when pursued, behavior that makes it difficult for dogs to single out calves. To scatter a herd, the dogs run beside it, mingle with it, and if it circles, charge toward the advancing animals. If no calf is present, another herd may be attacked. To pull a large calf or yearling off its feet sometimes requires several minutes of effort, with one or more dogs hanging on to the nose and neck of the quarry, several tearing at the legs, and the rest at the abdomen.

Once a dog flushed a mouse and

As Thomson's gazelle graze, a leopard watches from a nearby tree. Unless the gazelle come closer, the cat will not rush them.

Left to right: Wild dogs cut off and kill a young wildebeest. The descent of a vulture probably alerts a nomadic lion, which drives off the dogs and takes over the remains.

When wild dogs return to the den site after a hunt, pups beg food by nuzzling an adult. In a reflexive action, the adult dog regurgitates part of the food it consumed earlier at the kill.

then pawed it, snapped at it, and bounded in a tight circle around it. Three other dogs joined. The mouse squatted, paws raised, mouth agape; when a dog nudged it with a foot, it bit. Finally, after five minutes, longer than it normally takes to kill a wildebeest, one dog grabbed it.

When several predatory species hunt in the same area, competition for a limited prey resource is likely to occur. One way in which such competition can be reduced is for predators to occupy different habitats or to use the same one at different times. Although all habitats are used by the five large predators in the Serengeti, some animals are more abundant in one than another. Lions mainly occupy the woodlands, hyenas and cheetah the plains and woodlands-plains border, leopards the thickets and riverine forest, and wild dogs both woodlands and plains equally, depending on availability of prey. The cheetah and wild dog are diurnal, hunting predominantly in the morning and afternoon, whereas the others are nocturnal except in special circumstances, such as when lions stalk prey at waterholes.

The various predators are obviously not separated completely in space and time. Cheetah and wild dogs hunt during the same hours, but both are so scarce that they seldom meet. Attracted by each other's kills, lions and hyenas often come into conflict, particularly in the plains where they appropriate kills from each other. In general, predators tend to be intolerant of each other, even killing without provocation.

A clear distinction must be made, however, between hunting behavior and aggression, between

Hyenas, right, kill a sickly adult wildebeest, which had lagged behind when they chased its herd. In many areas the hyena is a major predator, killing most of its food.

predators killing each other for food and for other reasons. Leopards frequently catch small carnivores, such as jackals and servals, and eat them as any food item. Lions, however, may pursue hyenas, leopards, and cheetah, showing, not the inexpressive facial features of a hunt, but the bared teeth and vocalizations typical of intraspecific strife; they treat other predators as they would other lions. In this context it is interesting to note that lions usually attack man as another predator, rather than as a prey item.

It has been customary to divide the large African carnivores into predators, such as lions and wild dogs, which kill their own food, and scavengers, such as hyenas and jackals, which subsist mainly on the remains left by predators or on any other meat they can find. This distinction is not justified, for hyenas in the Serengeti kill two-thirds of their own food and jackals, more than four-fifths of theirs. And lions scavenge much of their food in some areas. For example, of 63 carcasses on which lions were feeding in Ngorongoro Crater, 81 percent had been killed by hyenas. Thus lions can be considered pure predators in one park and not in another, an awkward semantic distinction.

The predators, however, can be divided into stalkers and coursers based on their predominant hunting methods. Stalking is characteristic of most felids, coursing of canids. The cats are specialized to capture prey through stealth; in contrast, the canids, with their fairly long, slender legs and deep chests are designed for running fast and far. Lacking the curved claws and powerful arms of cats, they have to hold and pull down their prey with the teeth alone.

A large predator has a greater variety of hoofed animals available as prey than a small one. All five of the large predators capture prey weighing less than 200 pounds, whereas only lions kill animals scaling more than 300 pounds, except on rare occasions when hyenas attack them. Communal hunting also affects the size of prey that can be killed by predators. For example, judging by its size, a solitary wild dog would subsist on animals weighing less than 50 pounds, but packs readily kill prey of 250 pounds. With the spectrum of predators ranging from jackals to lions, competition for the same food resource is reduced and predation pressure is distributed more evenly over the prey population.

A predator's speed and endurance have an obvious effect on the frequency with which it can obtain a meal and the kind of prey it can catch. Hyenas have stamina but only moderate speed and agility. Lions and leopards are fairly slow and easily exhausted. This limits their pursuit to a short rush, a method whose success depends as much on the vulnerability of the prey ~~as~~ on the skill of the hunter. Stalkers may, however, increase their chances of success by hunting at night and near cover.

Lions, leopards, and hyenas may go two or more days without obtaining prey. When some is finally available they gorge themselves, with hyenas able to ingest one-third of their body weight in one meal and lions one-fourth—more than 75 pounds of meat in the case of a male lion. Food passes rapidly through the stomach, which means that they can soon eat more.

Excess meat may be stored, leopards placing theirs in trees, hyenas in water. Since wild dogs can maintain a high speed for considerable distances, their success in capturing gazelle is higher than that of hyenas. Similarly, the cheetah's sprint is so fast that its success rate of 70 percent for gazelle exceeds that of other species. Both these predators tend to capture prey daily and neither makes an effort to save excess meat.

It is interesting to speculate how a carnivorous hominid might have subsisted in the Serengeti, especially since man has been a member of this predator community since his evolutionary beginnings. A hominid could have obtained meat in one of four ways: by scavenging animals dead from disease, malnutrition, or other causes; by driving predators off their kill; by capturing newborn young, sick individuals, and other vulnerable prey; and by capturing healthy large mammals. All large predators in the Serengeti obtain meat by all four methods, with the exception of cheetah, which do not appropriate kills.

Some anthropologists visualize an evolutionary progression for man from vegetarian to scavenger to hunter. The fact that no large mammalian predator in the Serengeti subsists solely by scavenging suggests that hominids would also have found it difficult to do so unless they supplemented their diet with vegetal matter.

There is no ecological room for a total scavenger. For several days, I searched on foot for kills and dead animals in an area of great prey abundance. Where prey was abundant a carnivorous hominid might have survived by scavenging and killing sick animals, but where prey was sparse he would have had to hunt in order to survive. Like all predators, hominids probably obtained their meat in the easiest possible way, by scavenging and by killing the young and sick when possible; by pursuing healthy animals when nothing else was available.

The scavenging and hunting hominids' primate heritage suggests that they were diurnal. Selection pressures also undoubtedly favored a social existence. The wild dog, which hunts at dawn and dusk and favors prey weighing 125 pounds or less, was the only other diurnal social carnivore. Therefore, an ecological opening existed for a social predator that hunted large animals and scavenged during the day, an opening that an early hominid may well have filled.

(*Continued next month*)

While immature males may remain together, cheetah are normally solitary. They prey primarily on the small Thomson's gazelle.

Nights in Pliny's Garden

The insatiable scholar who wrote the first "Natural History" seems to have been too busy to sleep—except on the night before his death

by Phillip Drennon Thomas

From the first century to the nineteenth century, the most popular work on natural history was the *Historia naturalis* of Gaius Plinius Secundus, more commonly known as Pliny the Elder. This ponderous, 37-volume work became the basic reference source for medieval scholars who were interested in nature. It is probably the most popular work on natural history ever written. Certainly, it is one of the most interesting.

Although praised by Buffon, Humboldt, Cuvier, and a host of lesser critics, it is nevertheless a work that must be read with caution, for Pliny loved fable as well as fact. The historian Edward Gibbon referred to the *Natural History* as "an immense register where Pliny has deposited the discoveries, the arts, and the errors of mankind."

In his preface, Pliny informs his readers that his work contains 20,000 interesting facts, gleaned from 2,000 volumes by 100 authors, "of which only a few are in the hands of the studious on account of the obscurity of the subject." A careful examination of his work reveals that Pliny actually refers to 146 Latin authors and 327 foreign authors, including Homer—"a prince of learning and father of antiquities"—Aristotle, Herodotus, Xenophon, Thucydides, Euclid, Democritus, Archimedes, Theophrastus, Varro, Livy, Cato, Polybius, Eudoxus, Eratosthenes, Pindar, Hippocrates, Asclepiades, and King Juba of Numidia. We know of many early scientists and naturalists only because Pliny mentioned them.

Pliny inaugurated a tradition in scientific scholarship of carefully citing one's sources, for as he comments in his involved Latin prose, "I have prefaced these volumes with the names of my authorities. I have done so because it is, in my opinion, a pleasant thing and one that shows an honorable modesty, to own up to those who were the means of one's achievements, not to do as most of the authors to whom I have referred did. For you must know that when collating authorities, I have found that the most professedly reliable and modern writers have copied the old authors word for word, without acknowledgment."

Citing his authorities with care, Pliny sought to embrace nature in her broadest dimensions. Yet he realized that some subjects escaped his attention. "Nor do we doubt that there are many things that have escaped us also; for we are but human, and beset with duties, and we pursue this sort of interest in our spare moments, that is at night—lest any of your house [the emperor Vespasian] should think that the night hours have been given to idleness. The days we devote to you, and we keep our account with sleep in terms of health, content even with this reward alone, that, while we are dallying, in Varro's phrase, with these trifles, we are adding hours to our life—since of a certainty to be alive means to be awake."

The walls of Pompeii, when uncovered by archeologists, revealed a wealth of Roman mythology and natural history. The painting, left, is from the house of Vetti. Ostia, right, was Rome's main port when Pliny commanded its fleet.

Few matters escaped Pliny's attention, for the numerous books of his *Natural History* contain deliberations on agriculture, gems, drugs, birds, bees, babies, plants, medicine, monstrosities, omens and portents, magic and astrology, marvels of the sea, inventions and notable first events, and the shape, size, and motion of the world. They were a storehouse of the Mediterranean world's accumulated facts, folklore, and fables. Pliny provided a table of contents that included a survey of the subjects in each book, the authorities for the material, and in some cases, the number of facts, investigations, and observations presented in the book.

Pliny was interested in ascertaining when events first occurred and who invented mundane objects. Consequently, he provided illumination on Rome's first pavements, the first clock, when the Roman nation first began to squander money, who first invented fishponds, who first introduced goose liver, who were the first bakers in Rome, who were the richest people, the inventor of perfume, and when lions, tigers, and elephants were first seen in Rome.

The details of Pliny's life and career are meager. Born in A.D. 23, at Como in northern Italy, he was the son of an established, middle-class Roman family. Studying at Rome, he was influenced by the Stoicism of Seneca; and as a moderate Stoic himself, he believed that nature was didactic—it could instruct human society on the questions of virtue.

After studying law, he followed the traditional course of a Roman youth and placed his energy and talents at the service of the Roman state. As a member of Rome's legions and imperial bureaucracy, he served in Germany, Gaul, and Spain. During this time, he had the opportunity to visit Africa, the site of many of the wondrous peoples, places, and things that he recorded in his *Natural History*.

During his busy career, Pliny authored a treatise on the cavalry's use of the javelin, a biography of a friend, a history of Rome's wars with Germany, a study of rhetorical training, a work on grammar, and a history of his times. Unfortunately, only his 37-volume *Natural History* is extant. Shortly after the dedication of this work in A.D. 77, he received his fateful appointment as prefect of the Roman fleet at Misenum on the Bay of Naples.

Pliny was remarkably, almost inexplicably, energetic in compiling and organizing his *Natural History*. His nephew Pliny the Younger, whose letters provide such a perceptive view of Roman life in the first century of the Empire, describes his uncle's method of study in a letter to a friend:

"You will wonder how a man as busy as he was could find time to compose so many books and some of them too involving such care and labor. But you will be still more surprised when you hear that he pleaded at the bar for some time, that he died in his fifty-sixth year, that the intervening time was employed partly in the execution of the highest official duties, partly in attendance upon those emperors who honored him with their friendship.

"But he had a quick apprehension, marvelous powers of application, and was of exceedingly wakeful temperament. He always began to study at midnight at the time of the feast of Vulcan, not for the sake of good luck, but for learning's sake; in winter generally at one in the morning, but never later than two, and often at twelve. He was a most ready sleeper, insomuch that he would sometimes, whilst in the midst of his studies, fall off and then wake up again. Before daybreak he used to wait upon Vespasian, who also used his nights for transacting business, and then proceed to execute the orders he received. As soon as he returned home, he gave what time was left to study.

"After a short and light refreshment at noon, agreeably to the good old custom of our ancestors, he would frequently in the summer, if he was disengaged from business, lie down and bask in the sun; during which time some author was read to him, while he took notes and made extracts, for every book he read he made extracts out of, indeed it was a maxim of his, that 'no book was so bad but some good might be got out of it.' When this was over, he generally took a cold bath, then some slight refreshment and a little nap.

"After this, as if it had been a new day, he studied till suppertime, when a book was again read to him, which he would take down running notes upon. I remember once his reader having mispronounced a word, one of my uncle's friends at the table made him go back to where the word was and repeat it again; upon which my uncle said to his friend, 'Surely you understood it?' Upon his acknowledging that he did, 'Why then,' he said, 'did you make him go back again? We have lost more than ten lines by this interruption.' Such an economist he was of time!

"In the summer he used to rise from supper at daylight, and in winter as soon as it was dark: a rule he observed as strictly as if it had been a law of state. Such was his manner of life amid the bustle and turmoil of town: but in the country his whole time was devoted to study, excepting only when he bathed. In this exception I include no more than the time during which he was actually in the bath; for all the while he was being rubbed and wiped, he was employed either in hearing some book read to him or in dictating himself.

"In going about anywhere, as though he were disengaged from all other business, he applied his mind wholly to that single pursuit. A shorthand writer constantly attended him with book and tablets, who, in the winter, wore a particular sort of warm gloves, that the sharpness of the weather might not occasion any interruption to my

In his *Natural History* Pliny also wrote about mythical creatures, such as the satyr represented here in a statue uncovered in Pompeii.

uncle's studies: and for the same reason, when in Rome, he was always carried in a chair. I recollect his once taking me to task for walking. 'You need not,' he said, 'lose these hours.' For he thought every hour gone that was not given to study."

This passage clearly reveals that Pliny was a voracious reader rather than a trained naturalist interested in observing the phenomena of the world. Pliny was one of history's greatest note-takers and compilers. He was more a historian, in love with the wonders of nature as recorded by other writers, than a scientist devoted to examining the minute workings of nature.

Many of the flaws in his work are those that are symptomatic of the science of the period. In the tradition of the Greeks, his universe was geocentric, and his basic matter was the four elements of earth, air, fire, and water.

Pliny was neither more nor less credulous than other educated Romans of his era. He claimed his incredulity was based upon a detailed examination of nature: "For when I have observed Nature she has always induced me to deem no statement about her incredible."

Rome stood in awe before the intellectual accomplishments of the Greeks and the wondrous manifestations of nature's powers. Thus, it is not surprising that Pliny derives much of his information on cosmography, zoology, and botany from Greek sources. They were the recognized authorities in these areas, and Rome respected authorities. Nevertheless, Pliny had the traditional Roman ambivalency toward the Greeks. In one passage, he states, "Only do not let us be too proud to follow the Greeks, because of their far greater industry or devotion to study"; but later he notes, "It is astounding to what lengths Greek credulity will go; there is no lie so shameless as to lack a supporter." He was cautious in the use of some of his Greek sources, and he rejoiced to find certain of them in error. "It afforded me great amusement to read an exposure of Greek lies and fraud."

Throughout his work, Pliny was defensive about his self-ordained mission of chronicling nature's nuances. To justify his endeavors, he offers comments upon Rome's neglect of science. He noted that "nowadays it is necessary to investigate not only subsequent discoveries but also those that had already been made by the men of old, because general slackness has decreed an utter destruction of records. And for this fault who can discover other causes than the general movements of affairs in the world? The fact is that other customs have come into vogue, and the minds of men are occupied about other matters: the only arts cultivated are the arts of avarice." One of the constant themes in Pliny's work is his persistent indictment of Roman society's indifference to learning.

Pliny's world was adorned with marvelous peoples: the Ethiopians, whom you had to see to believe; the forest people of the Himalayas, who had their feet turned backward behind their legs and ran with wild animals; the Albanians, who were born with keen gray eyes and remained bald from childhood; the natives of India, who were "more than seven feet six inches high, never spit, do not suffer from head-

ache or toothache or pain in the eyes"; the umbrella foot tribe, who in hot weather lay on "their backs on the ground and protected themselves with the shadow of their feet"; and those notably strange mountain people who had dogs' heads and whose speech was a bark.

Pliny's explanation for these people was quite simple. "These and similar varieties of the human race have been made by the ingenuity of Nature as toys for herself and marvels for us. And indeed who could possibly recount the various things she does every day and almost every hour? Let it suffice for the disclosure of her power to have included the whole races of mankind among her marvels."

Pliny walked through the streets and arches of Pompeii, which were buried when Vesuvius, in the background, erupted.

The elephant was for Pliny one of the most spectacular inhabitants of the animal world. It was the first subject he considered in his books on zoology. While acknowledging it as the largest land animal, he was more enthralled by its human qualities. Pliny's elephant "is nearest to man in intelligence: it understands the language of its country and obeys orders, remembers duties that it has been taught, is pleased by affection and by marks of honor, nay more it possesses virtues rare even in man, honesty, wisdom, justice, also respect for the stars and reverence for the sun and moon." Pliny chronicled their first appearance in Rome, examples of their intelligence and moral sensibilities, prowess in war, and methods of training and breeding, and he reviewed their principal enemies—men and snakes. Pliny maintained that the biggest elephants were born in India, but he recorded that "Ethiopia produces elephants that rival those of India, being 30 feet high." After reading Pliny, it is easy to understand why the gullible scholars of the early Middle Ages so esteemed the elephant.

Pliny presented a lengthy commentary upon the lion, which, like the elephant, is an animal with nobility. "The lion alone of wild animals shows mercy to suppliants; it spares persons prostrated in front of it, and when raging it turns its fury on men rather than women, and only attacks children when extremely hungry."

In his descriptions of aquatic animals, he again began with the largest example of that class, the whale. He recognized that marine animals can be larger than those on land. The exotic East is the source once more for the premier example of a particular species. "The largest number of animals and those of the largest size are in the Indian Sea, among them whales covering three acres each, and sharks 100 ells [150 feet] long: in fact in those regions lobsters grow up to 6 feet long, and also eels in the river Ganges to 300 feet." Pliny reserves some of the most beautiful prose in his *Natural History* for the dolphin. Pearl-producing oysters are chastised by Pliny because "moral corruption and luxury spring from no other source in greater abundance than from the genus shellfish."

Concerned with Rome's abuse of her environment, Pliny delivers an impassioned plea against man's exploitation of his world. "In fact, in regard to one of nature's elements we have no gratitude. For what luxuries and for what outrageous uses does she not subserve mankind? She is flung into the sea, or dug away to allow us to let in the channels. Water, iron, wood, fire, stone, growing crops are employed to torture her at all hours, and much more to make her minister to our luxuries than our sustenance. Yet in order to make the sufferings inflicted on her surface and mere outer skin endurable, we probe her entrails, digging into her veins of gold and silver and mines of copper and lead; we actually drive shafts down into the depth to search for gems and certain tiny stones; we drag out her entrails, we seek a jewel merely to be worn upon a finger! How many hands are worn away with toil that a single knuckle may shine resplendent! If any beings of the nether world existed, assuredly even they would have been dug up ere now by the burrowing of avarice and luxury! And can we wonder if earth has also generated some creatures for our harm? Since the wild animals, I well believe, are her guardians, and protect her from sacrilegious hands: do not serpents infest our mines, do we not handle veins of gold mingled with the roots of poison? Yet that shows the goddess all the kinder to-

wards us, because all these avenues from which wealth issues lead but to crime and slaughter and warfare, and her whom we besprinkle with our blood we cover with unburied bones, over which nevertheless, when at length our madness has been finally discharged, she draws herself as a veil, and hides even the crimes of mortals. I would reckon this too among the crimes of our ingratitude, that we are ignorant of her nature."

Pliny's energetic efforts to dispel Rome's ignorance about nature ended suddenly at the foot of Mount Vesuvius, which erupted in volcanic fury on August 24, A.D. 79. By sunset on the 25th, Pliny the Elder was dead, and the cities of Pompeii, Herculaneum, and Stabiae were covered with ash. Pliny the Younger, who was eighteen at the time, recorded in a graphic letter to the historian Tacitus the incidents leading to his uncle's death.

"He was at that time with the fleet under his command at Misenum. On the 24th of August, about one in the afternoon, my mother desired him to observe a cloud which appeared of a very unusual size and shape. He had just taken a turn in the sun and, after bathing himself in cold water, and making a light luncheon, gone back to his books: he immediately arose and went out upon a rising ground from whence he might get a better sight of this very uncommon appearance.

"A cloud, from which mountain was uncertain, at this distance (but it was found afterwards to come from Mount Vesuvius), was ascending, the appearance of which I cannot give you a more exact description of than by likening it to that of a pine tree, for it shot up to a great height in the form of a very tall trunk, which spread itself out at the top into a sort of branches; occasioned, I imagine, either by a sudden gust of air that impelled it, the force of which decreased as it advanced upwards, or the cloud itself being pressed back again by its own weight, expanded in the manner I have mentioned; it appeared sometimes bright and sometimes dark and spotted, according as it was either more or less impregnated with earth and cinders.

"This phenomenon seemed to a man of such learning and research as my uncle extraordinary and worth further looking into. He ordered a light vessel to be got ready, and gave me leave, if I liked, to accompany him. I said I had rather go on with my work; and it so happened he had himself given me something to write out.

"As he was coming out of the house, he received a note from Rectina, the wife of Bassus, who was in the utmost alarm at the imminent danger which threatened her; for her villa lying at the foot of Mount Vesuvius, there was no way of escape but by sea; she earnestly entreated him therefore to come to her assistance.

"He accordingly changed his first intention, and what he had begun from a philosophical, he now carries out in a noble and generous spirit. He ordered the galleys to put to sea, and went himself on board with an intention of assisting not only Rectina, but the several other towns which lay thickly strewn along that beautiful coast.

"Hastening then to the place from whence others fled with the utmost terror, he steered his course direct to the point of danger, and with so much calmness and presence of mind as to be able to make and dictate his observations upon the motion and all the phenomena of that dreadful scene. He was now so close to the mountain that the cinders, which grew thicker and hotter the nearer he approached, fell into the ships together with pumice stones, and black pieces of burning rock: they were in danger too not only of being aground by the sudden retreat of the sea, but also from the vast fragments which rolled down from the mountain, and obstructed all the shore.

"Here he stopped to consider whether he should turn back again; to which the pilot advising him, 'Fortune,' said he, 'favors the brave; steer to where Pomponianus is.' Pomponianus was then at Stabiae, separated by a bay, which the sea, after several insensible windings, forms with the shore. He had already sent his baggage on board; for though he was not at that time in actual danger, yet being within sight of it, and indeed extremely near, if it should in the least increase, he was determined to put to sea as soon as the wind, which was blowing dead in-shore, should go down.

"It was favorable, however, for carrying my uncle to Pomponianus, whom he found in the greatest consternation: he embraced him tenderly, encouraging and urging him to keep up his spirits, and, the more effectually to soothe his fears by seeming unconcerned himself, ordered a bath to be got ready, and then, after having bathed, sat down to supper with great cheerfulness, or at least (what is just as heroic) with every appearance of it. Meanwhile broad flames shone out in several places from Mount Vesuvius, which the darkness of the night contributed to render still brighter and clearer. But my uncle, in order to soothe the apprehensions of his friend, assured him it was only the burning of the villages, which the country people had abandoned to the flames: after this he retired to rest, and it is most certain he was so little disquieted as to fall into a sound sleep: for his breathing which, on account of his corpulence, was rather heavy and sonorous, was heard by the attendants.

"The court which led to his apartment being now almost filled with stones and ashes, if he had continued there any time longer, it would have been impossible for him to have made his way out. So he was awoke and got up, and went to Pomponianus and the rest of his company, who were feeling too anxious to think of going to bed. They consulted together whether it would be most prudent to trust to the houses, which now rocked from side to side with frequent and violent concussions as though shaken from their very foundations; or fly to the open fields, where the calcined stones and cinders, though light indeed yet fell in large showers, and threatened destruction. In this choice of dangers they resolved for the fields: a resolution which, while the rest of the company were hurried into by their fears, my uncle embraced upon cool and de-

liberate consideration. They went out then, having pillows tied upon their heads with napkins; and this was their whole defence against the storm of stones that fell around them.

"It was now day everywhere else, but there a deeper darkness prevailed than in the thickest night; which however was in some degree alleviated by torches and other lights of various kinds. They thought proper to go farther down upon the shore to see if they might safely put out to sea, but found the waves still running extremely high and boisterous.

"There my uncle, laying himself down upon a sail-cloth, which was spread for him, called twice for some cold water, which he drank, when immediately the flames, preceded by a strong whiff of sulphur, dispersed the rest of the party, and obliged him to rise. He raised himself up with the assistance of two of his servants, and instantly fell down dead; suffocated, as I conjecture, by some gross and noxious vapor, having always had a weak throat, which was often inflamed. As soon as it was light again, which was not till the third day after this melancholy accident, his body was found entire, and without any marks of violence upon it, in the dress in which he fell, and looking more like a man asleep than dead."

So died Pliny the Elder, natural historian of Rome. The concluding words to his epic study of nature serve as a fitting epitaph:

> "Hail, Nature, Mother of all creation, and mindful that I alone of the men of Rome have praised thee in all thy manifestations, be gracious unto me."

Roman religious customs and art, combined in this statue of a vestal virgin at Ostia, were also topics of Pliny's voluminous works.

Mars Lives

by John P. Wiley, Jr.

Back before the turn of the century, some outstanding physicists were convinced that their discipline had been pretty well mined out; there was little left to do, they thought, but add a sixth decimal place to values that were already known. They did not even dream of protons and electrons; they had no glimpse of the power of understanding that quantum mechanics and relativity would bring. They did not know they were puttering in the dark just before a radiant dawn.

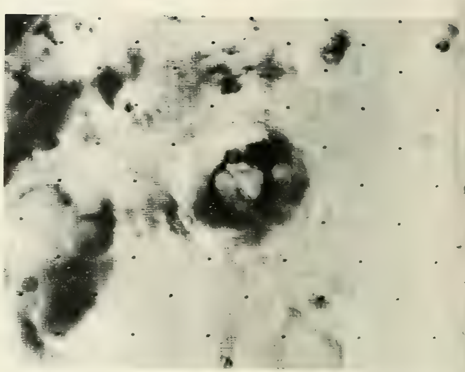
As late as 1955, planetary astronomers were in much the same position. Their work never actually stopped: ingenious manipulation of instruments and inspired guesses slowly added to our store of knowledge about our neighbors in space. Most of the work was done by a small band of extraordinarily patient observers, who spent hours peering through the eyepieces of telescopes, waiting for those rare occasions when our swirling atmosphere stood still for a few seconds, revealing the planets in a clarity of detail never seen in photographs. Then the observer rapidly sketched what he saw, slowly building up a record of what the planet looked like and what changes, if any, were taking place. Astronomers were prisoners under an ocean of turbulent air, and there seemed to be no way to climb to new plateaus of knowledge.

Pickings were slim. Venus was nearby and bright, but banks of clouds made the planet a blank disk. Mercury was never far from the sun, and showed such faint markings that astronomers even assigned it an erroneous rotation rate. Jupiter offered a nice, large disk, but the conspicuous belts had to be features of the atmosphere rather than the surface; all astronomers could do was follow the development of disturbances and the fortunes of the tantalizing Great Red Spot. The rings made Saturn beautiful, but the planet itself looked much the same as Jupiter, only smaller. Uranus and Neptune were tiny, featureless disks at impossible distances, and mysterious Pluto, not a proper outer planet at all, looked like a rather faint star.

Mars was the only planet whose surface could be seen clearly. Dark markings were mapped. Seasonal changes took place; a wave of darkening spread from the shrinking polar cap toward the equator in whichever hemisphere spring was occurring. Haze sometimes obscured all or part of the visible disk; storms could be tracked across the face of the planet.

Even Mars, however, did not reveal very much. It is only half the size of the earth, and most of the time is more than a hundred million miles away. At best, its disk is only 25 seconds of arc across: looking at it then is like looking at a dime a mile away. At worst, when Mars is on the other side of the sun from us, its disk shrinks to just five seconds of arc.

The astronomers did what they could with what they had, and a standard picture of Mars emerged. They destroyed the vision of Percival Lowell, who dreamed of intelligent creatures living on the banks of an intricate canal system, and the fun of H. G. Wells, who had his Martian monsters invade the earth. The lonely planetologists reported a cold, waterless world with a tenuous atmosphere and few if any of the requirements for terrestrial life. They called Mars a geologically dead world, just as they had pronounced the moon to be dead. They ruled that nothing ever happened there, no volcanoes, no earthquakes, nothing.



Dark splotches like these, not seen by the 19[illegible] Mariner although large enough to be seen fro[m] the earth, cover much of the Martian south temperate zone. The crater at center, with the dark ring inside, is about 77 miles across.

In a way, it might have been nice. We might have seen what a planet looks like when it first forms. If no geological processes had disturbed the surface of Mars, then it might have been a time machine, taking us back almost to the creation of the solar system. True, the volatile gases, water, and a few other primordial constituents might be gone, but the surface of the planet would be the original surface, the "before" picture of a planet.

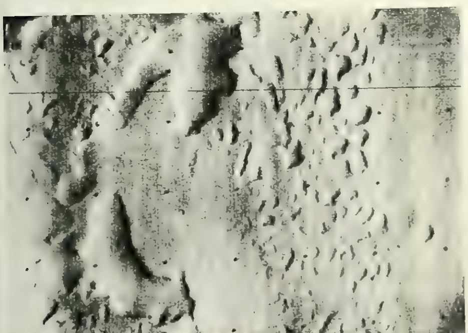
But physicists were destined to penetrate the atom, to calculate the curve of space, to create antimatter. A whole new picture of the physical universe emerged. Now the planetary astronomers are making the same quantum jump. They suddenly have access to instruments that not only have been lifted above the earth's atmosphere, but that have been carried to the celestial bodies they want to study. The small band has grown to an army. And now our conceptions of the

planets, especially of Mars, are changing almost daily.

It now appears we will have to look elsewhere for a primordial planet surface. The question of whether any biological life has succeeded against Martian odds remains open, but Mars as a planet is very much alive. We found out in 1965, when our first probe returned 17 pictures, that Mars is cratered like the moon. These could have been impact craters, however, which seemed especially likely on a planet so close to the asteroid belt. We discovered in 1969, when our second probes provided 200 pictures, that parts of the surface are jumbled up. We still do not know what causes that. Now another Mariner is circling the planet, sending back thousands of pictures, and among students of Mars all hell is breaking loose.

The rocketeers had their problems. One of the two Mariners launched last year got no farther than the Atlantic Ocean. When the successful one arrived after 248 million miles and five and a half months, all of Mars was blanked out by the worst dust storm in 17 years. The Soviets successfully dropped a television camera and scientific instruments to the planet's surface, only to hear the signals stop after 20 seconds, one of the all-time, great scientific disappointments.

By January the storm subsided, and there was joy at the Jet Propulsion Laboratory. The pictures were clear (although the color system failed), and they revealed completely unexpected surface features, so unexpected that the reaction of some scientists was described as "outraged disbelief."



Pits and hollows pock the surface of Mars about 500 miles from its south pole. They could result from the thawing of ground ice or from wind action. The basins at left are about ten miles across; the smaller pits are one to two miles in diameter.

Chasms range for miles across the Martian surface, some for hundreds of miles. They are complete with smaller tributary canyons, and look exactly like features carved by running water here on earth. The scientists' first reaction, however, is that they are the result of cracking and sliding of the crust of the sort usually produced by earthquakes. Wind erosion has further modified them. Other features, clearly cracks in the surface, run for more than 1,000 miles.

The surface is pocked in places with mysterious pits, not at all craterlike, ranging from a hundred miles across down to the smallest dimensions Mariner can photograph, about the size of Yankee Stadium. Other areas are dappled with equally mysterious "leopard spots," which change color from week to week and may be related to the waves of darkening that move across the planet in spring. Both of these phenomena could be nothing more than effects of the very high winds that apparently sweep the planet.

Some of the craters are collapsing, creating concentric rings of fractures in the surface, and appear to be the calderas of extinct volcanoes rather than the impact craters they had been assumed to be.

Instruments aboard Mariner have detected "hot spots," places as much as 10 degrees warmer than the surrounding area, which may be the sites of geothermal activity, possibly even active volcanoes.

The Martian winds themselves must be phenomenal. In November, when Mariner arrived, they were blowing hard enough to keep dust and sand suspended as much as 30 miles above the planet's surface. Known elevation differences of 40,000 feet and more could produce winds of up to 300 miles an hour, according to some estimates.

As January drew to a close, Mariner gave every indication that it would continue its probe of Mars for at least the three months aimed at by the designers. The only safe prediction had to be that still more surprises were in store. Two Soviet spacecraft were also taking pictures from orbits around Mars, and while they were providing copies to U.S. space scientists, none had been released to the public. But it was already clear that Mars is a far more exciting place than anyone has thought since Lowell and Wells dreamed their dreams of the red planet.

Physicists these days are happily boring into the ultimate nature of matter from a hundred different new directions. Planetary astronomers, and whole hosts of new colleagues who call themselves things like astrogeochemists, are now sitting under a cloudburst of information that will keep them busy for years; at least the years until their instruments take the next quantum step and start reporting directly from the sandy deserts of Mars.

Celestial Events

by Thomas D. Nicholson

After new moon on March 15, the moon enters the evening sky. It is at perigee (nearest earth) on the 16th, and from the 18th through the 20th appears as a crescent in the western sky after sundown, passing near the planets Venus, Mars, and Saturn. First-quarter moon occurs on the 21st; full moon on the 29th. Last-quarter moon occurs on April 6; new moon in April is on the 13th, followed by perigee about 10 hours later on the 14th.

Three planets dominate the evening sky through late March and early April. In mid-March, Venus, very brilliant, is well up in the southwest at sundown and remains visible for more than three hours. To the left and above, appearing later and much dimmer than Venus, you will find Mars and Saturn, both in Taurus, with Saturn the brighter of the two. Both Venus and Mars are moving rapidly east (left) each night, and by the end of March and through early April, they will be quite close to one another, and will overtake and pass Saturn (*see map below*). Mercury, also an evening star in March, is in favorable position until about the 20th—low in the west after sundown.

In the morning, you will find Jupiter among the stars of Sagittarius in the southern sky. The planet rises a few hours past midnight and remains visible until dawn, when it will be low in the south.

March 18: Venus and the moon are in conjunction.

March 19: The moon is in conjunction with Mars and, eleven hours later, with Saturn. At sundown, the crescent moon will be nearest Saturn, with Mars and Venus to the right and lower.

March 20: The sun arrives at the vernal equinox at 7:11 A.M., EST, and spring begins in the Northern Hemisphere.

March 31: Mercury, at inferior conjunction, enters the morning sky.

April 1: Mars and Saturn are in conjunction.

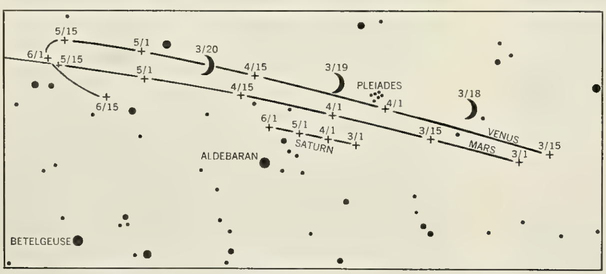
April 3: The waning gibbous moon is in conjunction with the star Antares, in Scorpius. The moon will be close to the star this morning and on the 4th.

April 7: Venus is at greatest elongation in the evening sky, 46 degrees to the left of the sun.

April 8: Venus and Saturn are in conjunction early this morning.

April 13-14: Greater than normal high tides can be expected from the perigee spring tide.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:25 P.M. on March 15; 9:20 P.M. on March 31; and 8:20 P.M. on April 15; but it can be used for about an hour before and after those times.



Positions are shown for Venus, Mars, Saturn, and the crescent moon.


N
CEPHEUS
CASSIOPEIA
DRACO
LITTLE DIPPER
Polaris
CAMELOPARDALIS
PERSEUS
PLEIADES
Venus
April 1
March 18
Capella
Mars
April 1
Saturn
April 1
BIG DIPPER
URSA MAJOR
TAURUS
Aldebaran
GEMINI
Castor
Pollux
Betelgeuse
ORION
Rigel
W
Denebola
LEO
Regulus
March 25
Procyon
HYDRA
Alphard
CRATER
Sirius
CANIS MAJOR

Devils, Witches, and Sudden Death

Continued from page 58

(Tios of the mines), asking for their care.

The female llama was the first to be sacrificed. She struggled and had to be held down by two men as they cut her jugular vein. When they disemboweled her, the men discovered that she was pregnant, to which they attributed the strength of her resistance. Her blood was caught in a white basin.

When the heart of the dying llama had pumped out its blood, the *yatiri* made an incision and removed it, using both his hands, a sign of respect when receiving an offering. He put the still palpitating heart in the basin with the blood and covered it with a white cloth on which the miners placed *k'oa*—an offering made up of herbs, coca, wool, and sweets—and small bottles of alcohol and wine.

The man in charge of the ceremony went with five aides to the site of the principal Tio in the main corridor. There they removed a piece of ore from the image's left side, creating a hole into which they put the heart, the blood, and the other offerings. They stood in a circle, their heads bent, and asked for safety and that there be no more accidents. In low voices, they prayed in Quechua.

When this commission returned, the *yatiris* proceeded to sacrifice the male llama. Again they asked the Tio for life and good ore in all the levels of the mine, and that there be no accidents. They took the heart, blood, *k'oa*, and bottles of alcohol and wine to another isolated gallery and buried it for the Tio in a place that would not be disturbed. There they prayed, "filled with faith," as one commented; then returned to the place of the sacrifice. The *yatiris* sprinkled the remaining blood on the veins of ore.

By their absorption and fervid murmuring of prayers, both young and old miners revealed the same faith and devotion. Many of them wept, thinking of the accident and their dead companions. During the ritual drinking was forbidden.

On the following day those men charged with responsibility for the ritual came to prepare the meat. They brought the two carcasses to the baker, who seasoned them and cooked them in large ovens. The men returned at about 1:15 P.M. to distribute the meat. With the meat, they served *chicha*. Some sprinkled *chicha* on the ground for the Pachamama, saying "Hallalla," before drinking.

The bones were burned to ashes, which were then offered to the Tio. The mine entrance was locked shut and left undisturbed for 24 hours. Some remarked that it should be closed for three days, but the company did not want to lose that much time.

During the *k'araku* the miners recognize the Tio as the true owner of the mine. "All the mineral that comes out from the interior of the mine is the 'crop' of the devil and whether one likes it or not, we have to invite the Tio to drink and eat so that the flow of metal will continue," said a young miner who studied evenings at the University of Oruro.

All the workers felt that the failure of the administrators to come to the *k'araku* indicated not only their lack of concern with the lives of the men but also their disregard of the need to raise productivity in the mine.

When the Tio appears uninvited, the miners fear that they have only a short time to live. Miners who have seen apparitions say the Tio looks like a gringo—tall, red-faced, with fair hair and beard, and wearing a cowboy hat. This description, hardly resembles the images sculptured by the miners, but it does fit the foreign technicians and administrators who administered the mines in the time of the tin barons. To the Indian workers, drawn from the highland and Cochabamba farming areas, the Tio is a strange and exotic figure, ruthless, gluttonous, powerful, and arbitrary in his use of that power, but nonetheless attractive, someone to get close to in order to share that power. I was beginning to wonder if the reason I was accepted with such good humor by the miners, despite their rule against women in the mines, was because they thought I shared some of these characteristics and was a match for the devil.

Sickness or death in the family can force a man in desperation to make a contract with the devil. If his com-

panions become aware of it, the contract is destroyed and with it his life.

The miners feel that they need the protection of a group when they confront the Tio. In the *ch'alla* and the *k'araku* they convert the power of the Tio into socially useful production. In effect, the rituals are ways of getting the genie back into the bottle after he has done his miracles. Security of the group then depends upon respect toward the sacrificial offering, as shown by the following incident told me by the head of a work gang after the *k'araku:*

"I know of a man who had a vein of ore near where the bones of the sacrificial llama were buried. Without advising me, he made a hole with his drill and put the dynamite in. He knew very well that the bones were there. On the following day, it cost him his life. While he was drilling, a stone fell and cut his head off.

"We had to change the bones with a ceremony. We brought in a good shaman who charged us B$500 [about $40], we hired the best orchestra, and we sang and danced in the new location where we laid the bones. We did not work in that corridor for three days, and we spent all the time in the *ch'alla.*"

Often the miners are frightened nearly to death in the mine. A rock falls on the spot they have just left, a man falls in a shaft and is saved by hitting soft clay at the bottom, a tunnel caves in the moment after a man leaves it—these are incidents in a day's work that I have heard men say can start a *haperk'a*, or fear, that can take their lives.

A shaman may have to be called in to bring back the spirit that the Tio has seized. In one curing, a frightened miner was told to wear the clothing he had on when the Tio seized his spirit and to enter and give a service to the Tio at the same spot where he was frightened. The shaman himself asked the Tio to cure his patient, flattering him, "Now you have shown your power, give back his spirit."

The fear may result in sexual impotency. At one of the mines, Siglo XX, when there is full production, a dynamite blast goes off every five minutes in a section called Block Haven. The air is filled with smoke and the miners describe it as an inferno. Working under such tension, a shattering blast may unnerve them. Some react with an erection, followed by sexual debilitation. Mad with rage and fear, some miners have been known to seize a knife, the same knife they use to cut the dynamite leads, and castrate themselves. When I visited Block Haven, I noticed that the Tio on this level had a huge erection, about a foot long on a man-sized figure. The workers said that when they find themselves in a state of impotency they go to the Tio for help. By exemplifying what they want in the Tio, they seek to repair the psychic damage caused by fear.

After feasting on the meat of the llamas and listening to stories of the Tio, I left the mine. The men thanked me for coming. I could not express the gratitude I felt for restoring my confidence in continuing the study.

Shortly thereafter I met Lino Pino returning from a fiesta for a miraculous saint in a nearby village. He asked me if I would be *madrina* at his daughter's forthcoming confirmation, and when I agreed, his wife offered me a tin cup with the delicious cocktail she always prepares for her husband on the days of the *ch'alla*, and we all had a round of drinks.

Later, when I knelt at the altar rail with Lino and his daughter as we received the wafer and the wine, flesh and blood of another sacrifice victim, I sensed the unity in the miners' beliefs. The miraculous Virgin looked down on us from her marbelized, neon-lit niche, her jewelled finger held out in benediction. She was adequate for that scene, but in the mine they needed someone who could respond to their needs on the job.

In the rituals of the *ch'alla* and the *k'araku* the power of the Tio to destroy is transformed into the socially useful functions of increasing mineral yield and giving peace of mind to the workers. Confronted alone, the Tio, like Banquo's ghost, makes a man unable to produce or even to go on living. Properly controlled by the group, the Tio promises fertility, potency, and productivity to the miners. Robbed of this faith, they often lose the faith to continue drilling after repeated failure to find a vein, or to continue living when the rewards of work are so meager. Knowing that the devil is on your side makes it possible to continue working in the hell that is the mines. ■

The Elephant Man

Continued from page 31

These tales were very real to him, as real as any narrative in the Bible, so that he would tell them to me as incidents in the lives of people who had lived. In his outlook upon the world he was a child, yet a child with some of the tempestuous feelings of a man. He was an elemental being, so primitive that he might have spent the twenty-three years of his life immured in a cave.

Of his early days I could learn but little. He was very loath to talk about the past. It was a nightmare, the shudder of which was still upon him. He was born, he believed, in or about Leicester. Of his father he knew absolutely nothing. Of his mother he had some memory. It was very faint and had, I think, been elaborated in his mind into something definite. Mothers figured in the tales he had read, and he wanted his mother to be one of those comfortable lullaby-singing persons who are so lovable. In his subconscious mind there was apparently a germ of recollection in which someone figured who had been kind to him. He clung to this conception and made it more real by invention, for since the day when he could toddle no one had been kind to him. As an infant he must have been repellent, although his deformities did not become gross until he had attained his full stature.

It was a favorite belief of his that his mother was beautiful. The fiction was, I am aware, one of his own making, but it was a great joy to him. His mother, lovely as she may have been, basely deserted him when he was very small, so small that his earliest clear memories were of the workhouse to which he had been taken. Worthless and inhuman as this mother was, he spoke of her with pride and even with reverence. Once, when referring to his own appearance, he said: "It *is* very strange, for, you see, mother was so beautiful."

The rest of Merrick's life up to the time that I met him at Liverpool Street Station was one dull record of degradation and squalor. He was dragged from town to town and from fair to fair as if he were a strange beast in a cage. A dozen times a day he would have to expose his nakedness and his piteous deformities before a gaping crowd who greeted him with such mutterings as "Oh! what a horror! What a beast!" He had had no childhood. He had had no boyhood. He had never experienced pleasure. He knew nothing of the joy of living nor of the fun of things. His sole idea of happiness was to creep into the dark and hide. Shut up alone in a booth, awaiting the next exhibition, how mocking must have sounded the laughter and merriment of the boys and girls outside who were enjoying the "fun of the fair!" He had no past to look back upon and no future to look forward to. At the age of twenty he was a creature without hope. There was nothing in front of him but a vista of caravans creeping along a road, of rows of glaring show tents and of circles of staring eyes with, at the end, the spectacle of a broken man in a poor law infirmary.

Those who are interested in the evolution of character might speculate as to the effect of this brutish life upon a sensitive and intelligent man. It would be reasonable to surmise that he would become a spiteful and malignant misanthrope, swollen with venom and filled with hatred of his fellow-men, or, on the other hand, that he would degenerate into a despairing melancholic on the verge of idiocy. Merrick, however, was no such being. He had passed through the fire and had come out unscathed. His troubles had ennobled him. He showed himself to be a gentle, affectionate and lovable creature, as amiable as a happy woman, free from any trace of cynicism or resentment, without a grievance and without an unkind word for anyone. I have never heard him complain. I have never heard him deplore his ruined life or resent the treatment he had received at the hands of callous keepers. His journey through life had been indeed along a *via dolorosa*, the road had been uphill all the way, and now, when the night was at its blackest and the way most steep, he had suddenly found himself, as it were, in a friendly inn, bright with light and warm with welcome. His gratitude to those about him was pathetic in its sincerity and eloquent in the childlike simplicity with which it was expressed.

As I learned more of this primitive creature I found that there were two anxieties which were prominent in his mind and which he revealed to me with diffidence. He was in the occupation of the rooms assigned to him and had been assured that he would be cared for to the end of his days. This, however, he found hard to realize, for he often asked me timidly to what place he would next be moved. To understand his attitude it is necessary to remember that he had been moving on and moving on all his life. He knew no other state of existence. To him it was normal. He had passed from the workhouse to the hospital, from the hospital back to the workhouse, then from this town to that town or from one showman's caravan to another. He had never known a home nor any semblance of one. He had no possessions. His sole belongings, besides his clothes and some books, were the monstrous cap and the cloak. He was a wanderer, a pariah and an outcast. That his quarters at the hospital were his for life he could not understand. He could not rid his mind of the anxiety which had pursued him for so many years—where am I to be taken next?

Another trouble was his dread of his fellow-men, his fear of people's eyes, the dread of being always stared at, the lash of the cruel mutterings of the crowd. In his home in Bedstead Square he was secluded; but now and then a thoughtless porter or a wardmaid would open his door to let curious friends have a peep at the Elephant Man. It therefore seemed to him as if the gaze of the world followed him still.

Influenced by these two obsessions he became, during his first few weeks at the hospital, curiously uneasy. At last, with much hesitation, he said to me one day: "When I am next moved can I go to a blind asylum or to a lighthouse?" He had read about blind asylums in the newspapers and was attracted by the thought of being among people who could not see. The lighthouse had another charm. It meant seclusion from the curious. There at least no one could open a door and peep in at him. There he would forget that he had once been the Elephant Man. There he would escape the vampire showman. He had never seen a lighthouse, but he had come upon a picture of the Eddystone, and it appeared to him that this lonely column of stone in the waste of the sea was such a home as he had longed for.

I had no great difficulty in ridding Merrick's mind of these ideas. I wanted him to get accustomed to his fellow-men, to become a human being himself and to be admitted to the communion of his kind. He appeared day by day less frightened, less haunted looking, less anxious to hide, less alarmed when he saw his door being opened. He got to know most of the people about the place, to be accustomed to their comings and goings, and to realize that they took no more than a friendly notice of him. He could only go out after dark, and on fine nights ventured to take a walk in Bedstead Square clad in his black cloak and his cap. His greatest adventure was on one moonless evening when he walked alone as far as the hospital garden and back again.

To secure Merrick's recovery and to bring him, as it were, to life once more, it was necessary that he should make the acquaintance of men and women who would treat him as a normal and intelligent young man and not as a monster of deformity. Women I felt to be more important than men in bringing about his transformation. Women were the more frightened of him, the more disgusted at his appearance and the more apt to give way to irrepressible expressions of aversion when they came into his presence. Moreover, Merrick had an admiration of women of such a kind that it attained almost to adoration. This was not the outcome of his personal experience. They were not real women but the products of his imagination. Among them was the beautiful mother surrounded, at a respectful distance, by heroines from the many romances he had read.

His first entry to the hospital was attended by a regrettable incident. He had been placed on the bed in the little attic, and a nurse had been instructed to bring him some food. Unfortunately she had not been fully infórmed of Merrick's unusual appearance. As she entered the room she saw on the bed, propped up by white pillows, a monstrous figure as hideous as an Indian idol. She at once dropped the tray she

was carrying and fled, with a shriek, through the door. Merrick was too weak to notice much, but the experience, I am afraid, was not new to him.

He was looked after by volunteer nurses whose ministrations were somewhat formal and constrained. Merrick, no doubt, was conscious that their service was purely official, that they were merely doing what they were told to do and that they were acting rather as automata than as women. They did not help him to feel that he was of their kind. On the contrary, they, without knowing it, made him aware that the gulf of separation was immeasurable.

Feeling this, I asked a friend of mine, a young and pretty widow, if she thought she could enter Merrick's room with a smile, wish him good morning and shake him by the hand. She said she could and she did. The effect upon poor Merrick was not quite what I had expected. As he let go her hand he bent his head on his knees and sobbed until I thought he would never cease. The interview was over. He told me afterwards that this was the first woman who had ever smiled at him, and the first woman, in the whole of his life, who had shaken hands with him. From this day the transformation of Merrick commenced and he began to change, little by little, from a hunted thing into a man. It was a wonderful change to witness and one that never ceased to fascinate me.

Merrick's case attracted much attention in the papers, with the result that he had a constant succession of visitors. Everybody wanted to see him. He must have been visited by almost every lady of note in the social world. They were all good enough to welcome him with a smile and to shake hands with him. The Merrick whom I had found shivering behind a rag of a curtain in an empty shop was now conversant with duchesses and countesses and other ladies of high degree. They brought him presents, made his room bright with ornaments and pictures, and, what pleased him more than all, supplied him with books. He soon had a large library and most of his day was spent in reading. He was not the least spoiled; not the least puffed up; he never asked for anything; never presumed upon the kindness meted out to him and was always humbly and profoundly grateful. Above all he lost his shyness. He liked to see his door pushed open and people to look in. He became acquainted with most of the frequenters of Bedstead Square, would chat with them at his window and show them some of his choicest presents. He improved in his speech, although to the end his utterances were not easy for strangers to understand. He was beginning, moreover, to be less conscious of his unsightliness, a little disposed to think it was after all, not so very extreme. Possibly this was aided by the circumstance that I would not allow a mirror of any kind in his room.

The height of his social development was reached on an eventful day when Queen Alexandra—then Princess of Wales—came to the hospital to pay him a special visit. With that kindness which marked every act of her life, the Queen entered Merrick's room smiling and shook him warmly by the hand. Merrick was transported with delight. This was beyond even his most extravagant dream. The Queen made many people happy, but I think no gracious act of hers ever caused such happiness as she brought into Merrick's room when she sat by his chair and talked to him as to a person she was glad to see.

Merrick, I may say, was now one of the most contented creatures I have chanced to meet. More than once he said to me: "I am happy every hour of the day." This was good to think upon when I recalled the half-dead heap of miserable humanity I had seen in the corner of the waiting-room at Liverpool Street. Most men of Merrick's age would have expressed their joy and sense of contentment by singing or whistling when they were alone. Unfortunately poor Merrick's mouth was so deformed that he could neither whistle nor sing. He was satisfied to express himself by beating time upon the pillow to some tune that was ringing in his head. I have many times found him so occupied when I have entered his room unexpectedly. One thing that always struck me as sad about Merrick was the fact that he could not smile. Whatever his delight might be, his face remained expressionless. He

could weep but he could not smile.

The Queen paid Merrick many visits and sent him every year a Christmas card with a message in her own handwriting. On one occasion she sent him a signed photograph of herself. Merrick, quite overcome, regarded it as a sacred object and would hardly allow me to touch it. He cried over it, and after it was framed had it put up in his room as a kind of ikon. I told him that he must write to Her Royal Highness to thank her for her goodness. This he was pleased to do, as he was very fond of writing letters, never before in his life having had anyone to write to. I allowed the letter to be dispatched unedited. It began "My dear Princess" and ended "Yours very sincerely." Unorthodox as it was it was expressed in terms any courtier would have envied.

Other ladies followed the Queen's gracious example and sent their photographs to this delighted creature who had been all his life despised and rejected of men. His mantelpiece and table became so covered with photographs of handsome ladies, with dainty knickknacks and pretty trifles that they may almost have befitted the apartment of an Adonis-like actor or of a famous tenor.

Through all these bewildering incidents and through the glamour of this great change Merrick still remained in many ways a mere child. He had all the invention of an imaginative boy or girl, the same love of "make-believe," the same instinct of "dressing up" and of personating heroic and impressive characters. This attitude of mind was illustrated by the following incident. Benevolent visitors had given me, from time to time, sums of money to be expended for the comfort of the *ci-devant* Elephant Man. When one Christmas was approaching I asked Merrick what he would like me to purchase as a Christmas present. He rather startled me by saying shyly that he would like a dressing-bag with silver fittings. He had seen a picture of such an article in an advertisement which he had furtively preserved.

The association of a silver-fitted dressing-bag with the poor wretch wrapped up in a dirty blanket in an empty shop was hard to comprehend. I fathomed the mystery in time, for Merrick made little secret of the fancies that haunted his boyish brain. Just as a small girl with a tinsel coronet and a window curtain for a train will realize the conception of a countess on her way to court, so Merrick loved to imagine himself a dandy and a young man about town. Mentally, no doubt, he had frequently "dressed up" for the part. He could "make-believe" with great effect, but he wanted something to render his fancied character more realistic. Hence the jaunty bag which was to assume the function of the toy coronet and the window curtain that could transform a mite with a pigtail into a countess.

As a theatrical "property" the dressing-bag was ingenious, since there was little else to give substance to the transformation. Merrick could not wear the silk hat of the dandy nor, indeed, any kind of hat. He could not adapt his body to the trimly cut coat. His deformity was such that he could wear neither collar nor tie, while in association with his bulbous feet the young blood's patent leather shoe was unthinkable. What was there left to make up the character? A lady had given him a ring to wear on his undeformed hand, and a noble lord had presented him with a very stylish walking-stick. But these things, helpful as they were, were hardly sufficing.

The dressing-bag, however, was distinctive, was explanatory and entirely characteristic. So the bag was obtained and Merrick the Elephant Man became, in the seclusion of his chamber, the Piccadilly exquisite, the young spark, the gallant, the "nut." When I purchased the article I realized that as Merrick could never travel he could hardly want a dressing-bag. He could not use the silver-backed brushes and the comb because he had no hair to brush. The ivory-handled razors were useless because he could not shave. The deformity of his mouth rendered an ordinary toothbrush of no avail, and as his monstrous lips could not hold a cigarette the cigarette-case was a mockery. The silver shoe-horn would be of no service in the putting on of his ungainly slippers, while the hat-brush was quite unsuited to the peaked cap with its visor.

Still the bag was an emblem of the real swell and of the knock-

about Don Juan of whom he had read. So every day Merrick laid out upon his table, with proud precision, the silver brushes, the razors, the shoe-horn and the silver cigarette-case, which I had taken care to fill with cigarettes. The contemplation of these gave him great pleasure, and such is the power of self-deception that they convinced him he was the "real thing."

I think there was just one shadow in Merrick's life. As I have already said, he had a lively imagination; he was romantic; he cherished an emotional regard for women and his favorite pursuit was the reading of love stories. He fell in love—in a humble and devotional way—with, I think, every attractive lady he saw. He, no doubt pictured himself the hero of many a passionate incident. His bodily deformity had left unmarred the instincts and feelings of his years. He was amorous. He would like to have been a lover, to have walked with the beloved object in the langorous shades of some beautiful garden and to have poured into her ear all the glowing utterances that he had rehearsed in his heart. And yet—the pity of it!—imagine the feelings of such a youth when he saw nothing but a look of horror creep over the face of every girl whose eyes met his. I fancy when he talked of life among the blind there was a half-formed idea in his mind that he might be able to win the affection of a woman if only she were without eyes to see.

As Merrick developed he began to display certain modest ambitions in the direction of improving his mind and enlarging his knowledge of the world. He was as curious as a child and as eager to learn. There were so many things he wanted to know and to see. In the first place he was anxious to view the interior of what he called "a real house," such a house as figured in many of the tales he knew, a house with a hall, a drawing-room where guests were received and a dining-room with plates on the sideboard and with easy chairs into which the hero could "fling himself." The workhouse, the common lodging-house and a variety of mean garrets were all the residences he knew. To satisfy this wish I drove him up to my small house in Wimpole Street. He was absurdly interested, and exam-

ined everything in detail and with untiring curiosity. I could not show him the pampered menials and the powdered footmen of whom he had read, nor could I produce the white marble staircase of the mansion of romance nor the gilded mirrors and the brocaded divans which belong to that style of residence. I explained that the house was a modest dwelling of the Jane Austen type, and as he had read *Emma* he was content.

A more burning ambition of his was to go to the theatre. It was a project very difficult to satisfy. A popular pantomime was then in progress at Drury Lane Theatre, but the problem was how so conspicuous a being as the Elephant Man could be got there, and how he was to see the performance without attracting the notice of the audience and causing a panic or, at least, an unpleasant diversion. The whole matter was most ingeniously carried through by that kindest of women and most able of actresses—Mrs. Kendal. She made the necessary arrangements with the lessee of the theatre. A box was obtained. Merrick was brought up in a carriage with drawn blinds and was allowed to make use of the royal entrance so as to reach the box by a private stair. I had begged three of the hospital sisters to don evening dress and to sit in the front row in order to "dress" the box, on the one hand, and to form a screen for Merrick on the other. Merrick and I occupied the back of the box which was kept in shadow. All went well, and no one saw a figure, more monstrous than any on the stage, mount the staircase or cross the corridor.

One has often witnessed the unconstrained delight of a child at its first pantomime, but Merrick's rapture was much more intense as well as much more solemn. Here was a being with the brain of a man, the fancies of a youth and the imagination of a child. His attitude was not so much that of delight as of wonder and amazement. He was awed. He was enthralled. The spectacle left him speechless, so that if he were spoken to he took no heed. He often seemed to be panting for breath. I could not help comparing him with a man of his own age in the stalls. This satiated individual was bored to distraction, would look wearily at the stage from time to time and then yawn as if he had not slept for nights; while at the same time Merrick was thrilled by a vision that was almost beyond his comprehension. Merrick talked of this pantomime for weeks and weeks. To him, as to a child with the faculty of make-believe, everything was real; the palace was the home of kings, the princess was of royal blood, the fairies were as undoubted as the children in the street, while the dishes at the banquet were of unquestionable gold. He did not like to discuss it as a play but rather as a vision of some actual world. When this mood possessed him he would say: "I wonder what the prince did after we left?" or "Do you think that poor man is still in the dungeon?" and so on and so on.

The splendor and display impressed him, but, I think, the ladies of the ballet took a still greater hold

upon his fancy. He did not like the ogres and the giants, while the funny men impressed him as irreverent. Having no experience as a boy of romping and ragging, of practical jokes or of "larks," he had little sympathy with the doings of the clown, but, I think (moved by some mischievous instinct in his subconscious mind), he was pleased when the policeman was smacked in the face, knocked down and generally rendered undignified.

Later on another longing stirred the depths of Merrick's mind. It was a desire to see the country, a desire to live in some green secluded spot and there learn something about flowers and the ways of animals and birds. The country as viewed from a wagon on a dusty high road was all the country he knew. He had never wandered among the fields nor followed the windings of a wood. He had never climbed to the brow of a breezy down. He had never gathered flowers in a meadow. Since so much of his reading dealt with country life he was possessed by the wish to see the wonders of that life himself.

This involved a difficulty greater than that presented by a visit to the theatre. The project was, however, made possible on this occasion also by the kindness and generosity of a lady—Lady Knightley—who offered Merrick a holiday home in a cottage on her estate. Merrick was conveyed to the railway station in the usual way, but as he could hardly venture to appear on the platform the railway authorities were good enough to run a second-class carriage into a distant siding. To this point Merrick was driven and was placed in the carriage unobserved. The carriage, with the curtains drawn, was then attached to the mainline train.

He duly arrived at the cottage, but the housewife (like the nurse at the hospital) had not been made clearly aware of the unfortunate man's appearance. Thus it happened that when Merrick presented himself, his hostess, throwing her apron over her head, fled, gasping, to the fields. She affirmed that such a guest was beyond her powers of endurance for, when she saw him, she was "that took" as to be in danger of being permanently "all of a tremble."

Merrick was then conveyed to a gamekeeper's cottage which was hidden from view and was close to the margin of a wood. The man and his wife were able to tolerate his presence. They treated him with the greatest kindness, and with them he spent the one supreme holiday of his life. He could roam where he pleased. He met no one on his wanderings, for the wood was preserved and denied to all but the gamekeeper and the forester.

There is no doubt that Merrick passed in this retreat the happiest time he had as yet experienced. He was alone in a land of wonders. The breath of the country passed over him like a healing wind. Into the silence of the wood the fearsome voice of the showman could never penetrate. No cruel eyes could peep at him through the friendly undergrowth. It seemed as if in this place of peace all stain had been wiped away from his sullied past. The Merrick who had once crouched terrified in the filthy shadows of a Mile End shop was now sitting in the sun, in a clearing among the trees, arranging a bunch of violets he had gathered.

His letters to me were the letters of a delighted and enthusiastic child. He gave an account of his trivial adventures, of the amazing things he had seen, and of the beautiful sounds he had heard. He had met with strange birds, had startled a hare from her form, had made friends with a fierce dog, and had watched the trout darting in a stream. He sent me some of the wild flowers he had picked. They were of the commonest and most familiar kind, but they were evidently regarded by him as rare and precious specimens.

He came back to London, to his quarters in Bedstead Square, much improved in health, pleased to be "home" again and to be once more among his books, his treasures and his many friends.

Some six months after Merrick's return from the country he was found dead in bed. This was in April 1890. He was lying on his back as if asleep, and had evidently died suddenly and without a struggle, since not even the coverlet of the bed was disturbed. The method of his death was peculiar. So large and so heavy was his head that he could not sleep lying down. When he assumed the recumbent

position the massive skull was inclined to drop backwards, with the result that he experienced no little distress. The attitude he was compelled to assume when he slept was very strange. He sat up in bed with his back supported by pillows; his knees were drawn up, and his arms clasped round his legs, while his head rested on the points of his bent knees.

He often said to me that he wished he could lie down to sleep "like other people." I think on this last night he must, with some determination, have made the experiment. The pillow was soft, and the head, when placed on it, must have fallen backwards and caused a dislocation of the neck. Thus it came about that his death was due to the desire that had dominated his life—the pathetic but hopeless desire to be "like other people."

As a specimen of humanity, Merrick was ignoble and repulsive; but the spirit of Merrick, if it could be seen in the form of the living, would assume the figure of an upstanding and heroic man, smooth browed and clean of limb, and with eyes that flashed undaunted courage.

His tortured journey had come to an end. All the way he, like another, had borne on his back a burden almost too grievous to bear. He had been plunged into the Slough of Despond, but with manly steps had gained the farther shore. He had been made "a spectacle to all men" in the heartless streets of Vanity Fair. He had been ill-treated and reviled and bespattered with the mud of Disdain. He had escaped the clutches of the Giant Despair, and at last had reached the "Place of Deliverance," where "his burden loosed from off his shoulders and fell from off his back, so that he saw it no more."

Postscript

The disorder from which John Merrick suffered is neurofibromatosis, or von Recklinghausen's disease. A spontaneous mutation in about 1 out of 3,000 births, it is due to a proliferation of cells in the delicate connective tissue surrounding nerves. In most cases the disorder is limited to nerves in the skin, but in Merrick's case the nerves in his bones were also affected, with the most monstrously deforming consequences. As far as I have been able to determine, Merrick's affliction was the worst case ever recorded. The disorder is usually not fatal, but there is no known cure for it.

It is not Merrick's physical disorder that is so much of interest to us as his personality. According to some psychologists, the unspeakable torment Merrick suffered for the greater part of his short life should have turned him into a misanthrope, full of hostilities and frustrations, with nothing but loathing and hatred for his exploiters. Instead, Merrick turned out to be a gentle, kindly, sensitive creature. He never uttered an unkind word about any of his former "impresarios." And he became a well-read, intelligent romantic who, in his newfound paradise, was happy every hour of the day.

His story is one of the most poignant in the annals of human experience. How could a creature so afflicted and so maltreated have developed into the kind of human being he became? Any answer can only be conjectural. My own view is that during his first three or four years he probably received a great deal of love from his mother, and that this love gave him the strength and the resolution to survive and overcome all the misery and wretchedness of his life. What his rescuer, Frederick Treves, somehow failed to mention is that Merrick always carried a small portrait painting of his mother with him. He must have remembered his mother and her love for him. Merrick's life is both a triumph of the human spirit and a testimony to the power of human love.

Frederick Treves, who became Merrick's guardian angel, went on to become England's leading surgeon and a distinguished teacher. He removed Edward VII's appendix the day before the prince was crowned king of England in January, 1902.

John Merrick died in 1890 at the age of 27. In February, 1923, ten months before he died at the age of 70, Frederick Treves's book, *The Elephant Man and Other Reminiscences*, appeared. At that time I first read the title story, here reprinted. ■

Attitudes on Acupuncture

Continued from page 16

They of course experience pain after the electroacupuncture anesthetic effect wears off, a matter of some nine hours. But even this postoperative pain can sometimes be alleviated by ordinary acupuncture, as James Reston of *The New York Times* discovered in the aftermath of his appendectomy at Peking's Anti-Imperialist Hospital.

What we had seen so impressed us that we asked many questions about the technique. We were told that the use of electricity in conjunction with acupuncture needles was very new. It had been introduced systematically only since the Cultural Revolution, which began in 1966, although some work had been carried out for about a decade before that. Nothing had been written about it for foreign consumption; there were only internal information bulletins circulating among Chinese medical facilities. It was thus obviously important that we act as couriers on our return.

Shortly after the first interview, we received many invitations to speak on our China experiences and were inevitably asked to repeat what we had seen about acupuncture. We were surprised, after several weeks, that no interest was being manifested by the medical profession and called attention to that fact in public. About a month later some friends showed us an article in *Medical World News* in which various experts were asked to express their opinions about our reports. One prominent neurophysiologist described what we had said as "just rubbish," and several physicians expressed their doubts that the facts were as we represented them. Similar articles followed in other journals. We were reminded that we were not competent medical observers, that remarkable anesthetic effects can be obtained by hypnosis and suggestion, that placebo treatments frequently produce significant effects, and that our Chinese hosts may, in fact, have used drugs in conjunction with the acupuncture. In reply, we could only assert that we had specifically asked about drugs and hypnosis, and had been told that these played no part in the operations we witnessed. Of course, the quotations of Chairman Mao are frequently recited before important events, and one of the four patients in fact clutched a copy of the "Little Red Book" to his breast throughout the operation, so that some sort of emotional fortification might have been involved. But if this is the case, it still must be recorded as an amazingly successful tactic, certainly deserving of respectful interest by doctors in the Western world. It is well known by anesthesiologists, but infrequently discussed in public, that general anesthesia is not without its dangers. It is very easy to put a patient to sleep, but not always so easy to wake him up, and the mortality figures are not insignificant. Thus, if a convenient and safe technique for local anesthesia were available, it might become very useful here.

Within the last several weeks, the picture in this country has begun to change a bit. Several well-known American physicians have now seen the operations in China and are describing them to their colleagues. As a result, several prominent anesthesiologists have now taken the point of view that the procedure obviously works and must be further investigated. We seem to be approaching the point where the data will be examined in a scientific manner, and a dispassionate decision made. This is certainly the way science ought to operate, and is much to be preferred to the arrogant dismissal of the reports as "just rubbish" without further investigation.

At this point, I am sure of the authenticity of what I witnessed, although I must agree that interpretation is difficult in the light of existing knowledge. But this could be very exciting, and it is precisely here that the Western medical world has much to do. For if the results cannot be explained solely on the basis of the nervous system, then we may have to invoke other systems or modalities that can control the sensation of pain. This could result in new insights into the operation of the human body or it might end up with a relatively trivial explanation. But since the Chinese seem very happy to blend Western medicine with traditional Chinese practices, should we be less willing to learn from the wisdom of the East? ■

The

Eskimo Way by Jean L. Briggs

Seasons of the Eskimo, photography and text by Fred Bruemmer. *New York Graphic Society, $15.00; 160 pp., illus.*

It is a commonplace that the spread of Western civilization has changed, often profoundly, the lifeways of the other cultures it has touched. We tend to see these changes primarily as an improvement in the standard of living of "deprived" or "underdeveloped" peoples. But while people often do adopt readily and gratefully the material benefits of Western civilization, they pay a price, often without realizing until too late that they will have to do so. The price consists in the loss of valued ways of thinking, ways of relating to people and to the natural environment, that are contradictory to the requirements of the new way of life.

An instance of this kind of problem is the sedentation of the Canadian Eskimo. Nomadism is a materially difficult life on the northern rim of the continent; it means living in a drafty tent or chilly igloo, struggling with heavy sleds over jagged ice ridges or through slushy snow in all kinds of weather; it means an uncertain food supply and even more uncertain medical help in case of need. But nomadism is much more than this. It is a total way of life, involving special attitudes toward the environment, social relations, and possessions. *Seasons of the Eskimo* gives us a glimpse of this way of life.

Fred Bruemmer is a photographer who has spent five years, off and on, living and hunting with Eskimo in the Canadian Arctic. This pictorial study of traditional Eskimo camp life is an outgrowth of those experiences. It is difficult to generalize about Eskimo life without either diminishing the variety of ways in which Eskimo hunters actually live or confusing the reader with a wealth of regionally specific detail. But here it is successfully done; Bruemmer has distilled the essence of camp life.

The first thing that strikes one about the book is its visual beauty. The photographs, which are arranged according to season, are superb, and the vividly written text introducing each season enhances the pictures rather than distracting attention from them. Unfortunately, the proofreading leaves something to be desired, for at least two of the captions describe events that are not taking place in the pictures: on page 87 a woman is mending a tear in a caribou hide, not cutting up meat, and on page 148 she is spreading sinew to dry for use as thread. Further, caribou tents (page 153) have nearly *died* out, not *dried* out. I also wish that some of the pictures were not quite so dark, especially a few close-ups of faces, which are beautifully natural and expressive.

But these are small annoyances. More important than the book's visual qualities is the story it tells, a story of Eskimo families living in small, isolated, self-sufficient hunting camps, dependent for life on their own skill and on the vagaries of weather and migratory game. It is a vanishing life, as the subtitle points out, but Bruemmer neither idealizes it nostalgically nor denigrates it as brutish and primitive, both mistakes that outsiders are too prone to make. It is evident that he has lived with Eskimo in a real sense, sharing not only their tents, food, and activities, but also to some extent their point of view. Bruemmer has experienced their joys, their hardships, and the values that give their life meaning: the excitement and challenge of the hunt; the enjoyment of food and of human warmth; and autonomy, that is, the freedom to live and hunt where and how one chooses, and to be governed by one's own mood and need.

However, Bruemmer's description of Eskimo life, while on the whole admirably empathic, is in one respect one-sided. Perhaps one might say that it is too Eskimo—too much as the Eskimo themselves would like to be perceived by out-

Summertime means relaxation
—and less clothing.

siders. Bruemmer gives an idealized picture of Eskimo personality, social life, and child rearing, understating the seamy side of their social relationships. He describes their values and defenses more accurately than their emotions. Eskimo are, as he says, "intensely social," but more often than we realize, their warm and smiling manner conceals distrust, hostility, or fear. "A happy person is a good person," they say, and by that they mean that he is a safe person: he can be trusted not to attack others. He is also safe from attack by others, since a major reason for aggression among Eskimo is fear, and a person who is pacific and friendly does not arouse fear.

Eskimo are generous—unbelievably so from our perspective—but their other selves would like to be stingy, and they often suspect their neighbors of being so. Food sharing is one of the most conflict-ridden situations in Eskimo life. Generosity is highly valued and highly rewarded by the good opinion of one's fellows. But when food is scarce, it is difficult not to be anxious; memories (and in some cases fantasies) of hunger are vivid, and in a variety of ways children are taught to hold on to food and hide it, even as they are taught to share it.

Eskimo present a calm face in adversity, but they don't always feel calm; they are not supposed to brood, but many do. Bruemmer suggests that gaiety may be a defense against despondency; he explains their autumn festivities in this way, as a reaction to the approach of winter darkness. Eskimo recognize the defensive value of gaiety in other situations too, and try to turn both unhappiness and anger into amusement. Unfortunately, it doesn't always work, and there are Eskimo—in camps as well as in towns—who are severely distressed.

Egalitarianism is another value that is sometimes honored more in the breach than in reality. Bruemmer says that "what power there was, lay within the community, in the rule of public opinion." And it is true that public opinion, in Eskimo camps as in other small kin-based societies, is a major sanction. However, in traditional Eskimo society, shamans, by threatening illness, famine, or death, also wielded considerable power, both over individuals and over the group as a whole. "My helping spirit wants to sleep with your wife," a shaman might say, and the woman and her husband would have no recourse.

Finally, in my experience Eskimo child rearing is not quite as gentle as Bruemmer perceives it to be. It is true that in general children are profoundly loved and are not physically punished. It is also true that children are allowed a great deal of freedom to grow and learn at their own rate, on the assumption that as their minds develop, their behavior will increasingly conform to the desirable. However, although they don't always admit it, adults usually find it necessary to supplement the gentle instruction described by Bruemmer with stronger measures. The ridicule Bruemmer mentions is much more than "occasional"; it is pervasive. It is so subtle as to be largely invisible to non-Eskimo observers, but very early, children acquire a strong fear of unkindness and a sensitivity to criticism, which goes a long way toward explaining their mystifying good behavior. Indeed, I have heard elderly parents say that the children who care most for them in their old age are those they scolded most when they were young.

These are, however, relatively minor criticisms of a book that does not pretend to be an ethnography. In fact, it is impressive that through carefully selected pictures, supplemented by fewer than thirty pages of text, Bruemmer manages to convey as full a sense of traditional Eskimo life as he does. The ecological and historical background material he provides is scholarly without being obtrusive, and he also makes some cogent points about the effects of the white man on the cultural and ecological balance of the north and the resultant dilemma of the Eskimo. The book does extremely well what it sets out to do: it portrays poignantly and perceptively a valuable and vanishing way of life. It is ironic that some of the values being destroyed by settlement life are values that "civilized" man also holds dear but rarely manages to attain: the freedom to govern one's own life and to live it at one's own pace, the opportunity to do work that is intrinsically satisfying, a variety of experience (we are aware of the existence of variety in our world, but how many of us actually experience it?), and the capacity to enjoy, really enjoy, leisure. And it is tragic that, ensconced

in a comfortable settlement life, a former hunter can say, as one did say to me, "I am worthless here."

Jean L. Briggs is a member of the Department of Sociology and Anthropology at Memorial University of Newfoundland, Canada. She tells of her own experience among the Eskimo in her book Never in Anger *(Harvard University Press).*

THE HUMAN AVIARY, by George Holton and Kenneth E. Read. *Charles Scribner's Sons, $6.95; 62 pp., illus.*

This is a brilliant book, the beauty and vividness of the colored photographs well matched by the style of the prose essay that accompanies them. Holton has combed New Guinea and the adjacent islands for scenes of contrast: for the lonely landscapes, the men with feathered headdresses and faces painted in bright primary colors, bird of paradise feathers in their hair, faces masked and decorated for festive and warlike occasions. Read reacted to his anthropological work in New Guinea with a great sense of the poignancy of the human adventure, wherever found. His previous, autobiographical book, *The High Valley*, probed deeply into his own feelings of attraction and repulsion for the savagery and the humanity of these people—the last remnants of the Stone Age to be explored and recorded, photographed and tape recorded by modern man.

In this book, he always writes in a high key, so of New Guinea, "like a prehistoric mother bird marshaling a fledgling flock . . . and in the early morning as it stirs beneath the cover of its clouds, the air seems filled with its ruminations on the themes of men and time. It existed long before man found protection under its rainbow plumage. The millennia in which he counts his journey from his primate origins are less than a single heartbeat of its own life, and like an ancient symbolic elder it stands aside, reserving its judgment on the divided nature of the recent species."

While Holton picks up the inner surface of a leaf, the bright hues of a bird, a face, or a carving, Read compares the culture of New Guinea to the whole human effort, and its treatment of the human theses that "other cultures have attempted to enshrine in imperishable stone and marble." For here are bark and feathers and always paint: paint donned for each special occasion—and washed away when the feast or the battle is over—making it easy for men a few miles apart to distinguish themselves by different styles of headdress and face painting. Allusions to the proud efforts of civilization, to Versailles, François I at the Field of the Cloth of Gold, "the effigy of a king on the lid of a sarcophagus under twilight arches of a great cathedral," obelisks and pyramids, the Arc de Triomphe, a "brooding Lincoln in a neo-Grecian temple," and Lenin's Tomb on May Day, all serve to tie the pride, the ferocity, and the artistic flambovance of New Guinea peoples to our own bloody and heroic past.

Read did his own field work in the highlands and it is the sense of the highlands, where "earth is steeped in air," that dominates the book, although Holton has ranged far afield, to the Sepik, to the Trobriand Islands. It is the savagery of the highland peoples that preoccupies Read. "These iridescent congregations of people, flocks of bizarre creatures reminiscent of illustrations in a medieval bestiary, these scintillating, shouting, drumbeating, earth-pounding human beings are expressing a commitment probably as old as man, a parochial commitment to the grandeur and accomplishments of the group, which out from tribal beginnings as the world shrank, resulted in militant nationalism."

This is one way in which a sensitive, modern human being and a photographer seeking always for the special may present New Guinea to the foreign reader. There is scarcely a hint of how dark and dank the island often is, how many miles one can travel in the endless green before seeing a flash of bright bird wing or a single bright flower, how seldom the feathers and the paint relieve the drudgery and patience of life where so many children die, and women carry, carry, carry from place to place. What the traveler sees very occasionally—except at one of the great annual dance festivals arranged by the government—is crowded into this gorgeous little book, condensed into an hour of enjoyment, of which one might say with Kipling:

I have written the tale of our life
For a sheltered people's mirth
In jesting guise but ye are wise,
And ye know what the jest is worth"

Although the "jest" is brightly painted, the guise is somber in spite of the jeweled prose in which the name of the bird of paradise is an "echo of some universal feeling of a lost and irretrievable innocence." But the bird of paradise is not what the people of New Guinea call it.

This is a book for modern man.

MARGARET MEAD
The American Museum

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INDEX
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Central Park West at 79th Street
New York, N.Y. 10024

NOTE: Certain bands of *The Language and Music of the Wolves*, the long-playing record we distributed last spring, contain, in addition to the howls of wild and captured timber wolves, the howls of coyotes and coyote-dog hybrids; specifically parts of the last quarter of Side 1 and of Bands 1, 8, 9, 10, and 11. The tapes of these howls are owned by the Ontario Department of Lands and Forests, which played no role in the production of the record or its jacket. The magazine regrets that these additional data were omitted on record and jacket copy.

The American Museum is open to the public every day during the year, except Thanksgiving and Christmas. Your support through membership and contributions helps make this possible. The Museum is equally in need of support for its work in the fields of research, education, and exhibition.

This list details the photographer or other source of illustration by page.

COVER—AMNH
8—E. Raymond Hall
14—Arthur W. Galston
22—Courtesy of Outerbridge and Dienstfrey
33-42—AMNH
45-47—Alexander McD Davis
48-51—Charles Wolcott
52-59—June Nash
60—George B. Schaller
62—AMNH
65-67—Norman Myers, Bruce Coleman, Inc.
69—Wildlife Photographers, Bruce Coleman, Inc.
70-77—Phillip Drennon Thomas
78-79—NASA
80-81—Helmut Wimmer
96-98—Fred Bruemmer

Suggested Additional Reading

ATTITUDES ON ACUPUNCTURE

THE CHINESE ART OF HEALING. S. Pálos. Translated by Translagency, Ltd. Herder and Herder, Inc., New York, 1972.

EDUCATION AND SCIENCE IN CHINA. E. Signer and A. W. Galston. *Science,* January 7, 1972, pp. 15-23.

NOW, ABOUT MY OPERATION IN PEKING. J. Reston. *The New York Times,* July 26, 1971.

THE ELEPHANT MAN

ATTACHMENT. J. Bowlby. Vol. 1 of ATTACHMENT AND LOSS. Basic Books, Inc., New York, 1969.

EARLY EXPERIENCE AND BEHAVIOR. G. Newton and S. Levine, eds. Charles C. Thomas, Publisher, Springfield, 1968.

MEMOIRS OF A MIDGET. W. de la Mare. Alfred A. Knopf, Inc., New York, 1922.

OF LEMURS AND MEN

LEMUR BEHAVIOR. A. Jolly. University of Chicago Press, Chicago, 1966.

LEMUR SOCIAL BEHAVIOR AND PRIMATE INTELLIGENCE. A. Jolly. *Science,* July 29, 1966, pp. 501-506.

THE LEMURS OF MADAGASCAR. J.-J. Petter. A chapter in PRIMATE BEHAVIOR. I. DeVore, ed. Holt, Rinehart & Winston, Inc., New York, 1965.

PRIMATE EVOLUTION. E. Simons. The Macmillan Co., New York, in press.

THE RED BADGE OF RIVALRY

MECHANISM OF ANIMAL BEHAVIOR. P. Marler and W. Hamilton. John Wiley & Sons, Inc., New York, 1966.

THE STUDY OF INSTINCT. N. Tinbergen. Oxford University Press, Glasgow, 1969.

A COMPARATIVE STUDY OF THE BEHAVIOR OF RED-WINGED, TRI-COLORED AND YELLOW-HEADED BLACKBIRDS. G. H. Orians and G. M. Christman. University of California Publications in Zoology, Vol. 84, University of California Press, Berkeley, 1968.

DEVILS, WITCHES, AND SUDDEN DEATH

BOLIVIA: THE UNCOMPLETED REVOLUTION. J. M. Malloy. University of Pittsburgh Press, Pittsburgh, 1970.

LAND REFORM AND SOCIAL REVOLUTION IN BOLIVIA. D. B. Heath et al. Praeger Publishers, Inc., New York, 1968.

NIGHTS IN PLINY'S GARDEN

NATURAL HISTORY. Pliny the Elder. Harvard University Press, Cambridge, 1936-1962.

ROMAN SCIENCE. W. H. Stahl. The University of Wisconsin Press, Madison, 1962.

A HISTORY OF MAGIC AND EXPERIMENTAL SCIENCE, Vol. 1. L. Thorndike. Columbia University Press, New York, 1923.

is processed and shipped to other Reynolds facilities where it is "re-cycled" back into usable aluminum sheet, plate or other mill products.

Reynolds helps put "recycling" into the ecology dictionary.

Reynolds recycling program helps do two important jobs: It conserves valuable national resources, and helps with our litter and solid waste disposal problems.

One of Reynolds Mobile Reclamation Units to aid collection of all-aluminum cans.

The program is working: The aluminum industry has recycled over a billion cans, three-fourths of which were recycled in 1971 alone. More than $4.3 million were paid to the American consumer for this metal—with no municipal disposal cost.

Reynolds now operates 13 permanent reclamation plants and 11 mobile collection units. In addition, other leading companies, chiefly beverage manufacturers and distributors, are working with us in this effort to pick up and recycle every possible pound of household scrap aluminum. Today, there is a network of more than 633 satellite centers in 31 states.

Some of the companies working with Reynolds in collecting and recycling aluminum cans.

Adolph Coors Company
Anheuser-Busch, Inc.
P. Ballantine & Sons
Blitz-Weinhard Company
Carling Brewing Company
Falstaff Brewing Corporation
Jos. Schlitz Brewing Company
Theo. Hamm Company
Miller Brewing Company
Mobil Oil Corp.
Olympia Brewing Company
Pepsi-Cola Company
Piel Bros., Inc.
Rainier Brewing Company
The Coca-Cola Company
Union Oil Co. of California

What makes the effort work is the basic value of aluminum. Scrap aluminum is worth $200 a ton; other common packaging materials are worth only $16 to $20 a ton.

Because of this, we feel our can collection program is just the start of much larger and more effective attacks on the nation's solid waste disposal problem.

Aluminum's value can help pay for the recycling of much of the solid waste this country generates. Here, for example, are a few of the approaches Reynolds is involved in:

Will the homemaker separate?

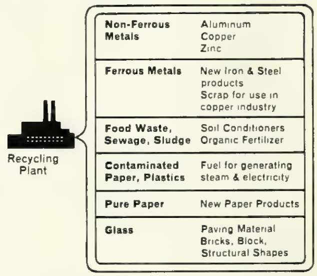
If housewives would separate recyclable materials from the rest of their daily trash, municipal refuse disposal costs would be greatly reduced, and recycling could be that much easier. It is estimated that if 1,000 households separated waste paper, aluminum cans, and glass bottles for recycling programs rather than throwing them away, a community could save over $50,000 in a year.

- Reynolds is now working with communities in Florida and California, providing free plastic bags to encourage household separation of waste. The goal is to see if the value of the aluminum will pay for part of the collection service.

Working with B.I.R.P. and cities.

- In Phoenix, Reynolds is part of the Beverage Industry Recycling Program (B.I.R.P.), helping to operate a model facility that is recycling aluminum, glass, and steel.
- We're talking with school systems about plans to collect used aluminum containers and foil from their cafeterias, the proceeds to help pay for school operations.
- In the San Francisco area, we're one of nine companies and municipalities planning a new, sophisticated reclamation plant. Here, aluminum, steel, paper, and glass raw materials will be separated automatically from mixed municipal garbage.
- Through the Aluminum Association, we've helped develop plans for garbage processing plants that could help pay for themselves by recovering aluminum and other raw materials. They would also produce valuable chemicals, fertilizers, animal feeds, and steam power.

Garbage in. Valuable raw materials out.



The American standard of living is creating a garbage pile that is now a national problem. But the value of aluminum in the garbage could turn this national problem into a national asset. *To learn more about what Reynolds is doing, write Dr. Robert F. Testin, Director of Environmental Planning, Reynolds Metals Company, P.O. Box 27003-LII, Richmond, Va. 23261. The men and women at Reynolds are always interested in your comments and suggestions.*

recyclable aluminum

REYNOLDS *where new ideas take shape in* ALUMINUM

NATURAL HISTORY

APRIL 1972 • $1.00

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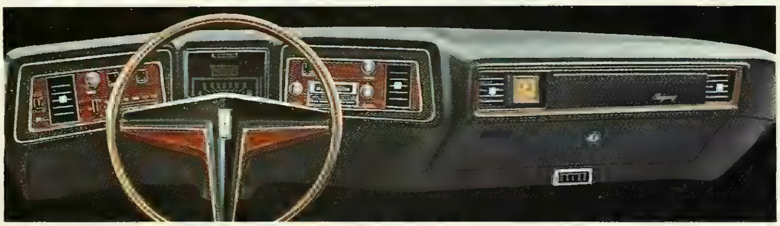
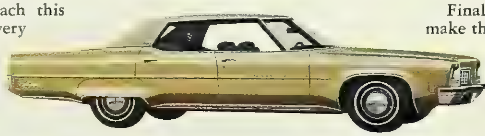
GM
MARK OF EXCELLENCE





NATURAL HISTORY

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY INCORPORATING NATURE MAGAZINE

The American Museum of Natural History

Gardner D. Stout, President *Thomas D. Nicholson, Director*

Vol. LXXXI, No. 4 April 1972

COVER: *Demon deities, like this eighteenth-century Peking example, protect Buddha's faithful followers and show the dead the path to enlightenment.*

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Authors

After nearly thirty years of studying seals, **Victor B. Scheffer** has not lost his enthusiasm for these animals. His work is now centered in the Puget Sound area of Washington, where he is investigating the behavior and life cycles of harbor seals. Although officially retired, Scheffer still teaches an occasional zoology course at the University of Washington and has kept busy as an author. He last appeared in Natural History Magazine with "The Cliché of the Killer," October, 1970, and his latest book, *The Seeing Eye,* was published last year by Charles Scribner's Sons.

Victor B. Scheffer

Whether making string from a sansevieria leaf à la the Bushmen, top center, or screening a film on baboon social structure, **Peter B. Dow** is thoroughly involved in an innovative program that brings anthropology to the elementary school classroom. He is director of the social studies program of the Education Development Center in Cambridge, Massachusetts, which developed "Man: A Course of Study" specifically for young children. Dow, who feels that the study of human behavior at this level may be more valuable than the traditional social studies, is currently constructing a course designed to stimulate sixth and seventh graders into investigating the uses of technology in their communities.

Peter B. Dow

Asked by a New York gallery to write the catalog for a Tibetan art show, **Carin Burrows**, acting curator of the Tibetan collection at The American Museum of Natural History, recognized among the pieces a priceless set of *t'angkas* representing the famous pantheon selected by the Changcha Hutuktu, the Grand Lama of Peking, in the eighteenth century. These scroll paintings were acquired by an official of the Belgian Embassy in Peking during the Chinese Revolution of 1911. His sons, who inherited the *t'angkas,* had put them up for sale at the gallery. Recognizing their significance and value for scholars, Burrows was instrumental in The American Museum's acquisition of the set. An anthropology graduate of Columbia University, Burrows has specialized in the study of Tibetan art and religion.

Carin Burrows

For **George B. Schaller** to see the last of his three-part series on predators of the Serengeti, a runner will carry it for almost a week into a remote mountain region of Nepal. Schaller, who went to Nepal in February for an extended study of the snow leopard, wild sheep, and wild goat, writes that "wildlife research in South Asia has been woefully neglected by foreign and native scien-

George B. Schaller

tists alike," adding that "some 15 scientists are at present working in the Serengeti, more than in all South Asia." An associate of the Institute for Research in Animal Behavior of the New York Zoological Society and Rockefeller University, Schaller's three-year study in the Serengeti was done under a grant from the National Science Foundation. In addition to a University of Chicago Press ecological monograph, from which the excerpts were taken, he has written *Serengeti: A Kingdom of Predators,* to be published by Knopf this fall.

Conversations with an environmentally minded student prompted **Michael D. Piburn** to think about the problem of waste recycling. The more he examined the problem, the more convinced he became that glass was a key issue. His unusual proposal for recycling waste glass, discussed in this issue, would also, unfortunately, spell an end to his own hobby of collecting antique bottles from old garbage dumps. Piburn, who received a Ph.D. in geology from Princeton, is assistant professor of education and geology at Rutgers University. He has conducted geologic field work in the

Michael D. Piburn

Coast Ranges of Venezuela, which at times entailed adventurous boat trips, above. He plans future studies of the origin of zeolite minerals in the Triassic basalts of the eastern United States.

To study the interrelation of ecology and behavior in the giant Komodo monitor lizards, **Walter Auffenberg** has made two expeditions to the Lesser Sunda Islands of Indonesia, one for a year's stay on Komodo Island with his family. The living wasn't easy, but the work was rewarding for this herpetologist whose major research interest has been the behavior and evolution of large land reptiles. His studies have also included the biosystematics of fossil and recent land tortoises, research that took him to India, Israel, Argentina, Panama, Mexico, and the Caribbean. Auffenberg is professor of zoology at the University of Florida, where he obtained his Ph.D., as well as curator of herpetology and chairman of the Department of Natural Sciences at the Florida State Museum.

Walter Auffenberg

James M. Acheson

The tradition-bound territoriality of Maine lobstermen has important implications for the future of these crustacean delicacies, an ecological phenomenon uncloaked by **James M. Acheson**, assistant professor of anthropology at the University of Maine. A native New Englander, Acheson had long been aware of the unofficial, self-imposed rules that, in effect, govern who fishes for lobsters, where, and when. It was the destruction of a friend's gear, however, that launched him into a thorough study of the mores and customs involved. Presently working on winter shrimping activities in Maine, Acheson will return to the site of previous field work in Cuanojo, Mexico, this summer. He holds a Ph.D. in anthropology from the University of Rochester.

Letters

Honey Cat

The unhappy bronze gent scowling at his pigeoned patina on the cover of your January issue is part of the great Donatello equestrian statue in Padua. To call him General Gattamelata, however, is like using a cover photo of General Pershing and identifying it only as "General Black Jack."

His name was Erasmo di Narni. He was one of the outstanding mercenary commanders of the *condottieri* period in Italy's history. His nickname, "Gattamelata," was a tribute to his skill and agility. It means "the honeyed cat."

F. L. GREAVES
Tempe, Arizona

Blame the Hired Hand?

Reference is made to the fine article "Letter From a Farmer," by J.O. Harvey (January, 1972) with which I am in general agreement. I would like only to raise a word of defense for certain of Miss Harvey's culprits whom she refers to as the "myopic hired hands of the government," who build roads, dams, lagoons, etc. The term *engineers* is not used, though the implication is obvious, and the charge is not without some justification.

Engineers are being subjected to much criticism today by environmentalists and conservationists who seem to consider them enemies of their cause. Are not such critics overlooking the fact that the great majority of engineers are the hired hands of government or industry and, as such, are only doing what they are hired to do? Should not the criticism be aimed also at the source of the iniquity? Failure to do so would appear to be analogous to blaming the privates and non-coms for a debacle on the battlefield without mentioning the general officers. Perhaps the engineer should quit his job if he finds himself engaged in a project in which he does not believe, but if he cannot see his way clear to do this, he has many counterparts in other walks of life.

Those with the best brains in the engineering profession today, whose minds are not fettered by the dictates of their "superiors," are deeply concerned about the environment and conservation, and many of them are hard at work on the vital problems in these fields. If the public is not aware of them, it is partly because such men are not likely to be seen on television being interviewed by a cub reporter who, like the hired engineer, is trying to get the answers his boss wants.

ELMER B. STEVENS
Ocala, Florida

If West Meets East

If the Pacific sea snakes (William A. Dunson, "The Sea Snakes are Coming," November, 1971) coming from salty, relatively cool water, ever get to the Caribbean through a sea-level Panama Canal, they will find very warm, turbid water, with a lower salinity than they are accustomed to, especially near the shore. I seriously doubt that they can make the change and colonize under those conditions.

I am well acquainted with the fact that Dr. Dunson was also concerned about possible ecological damage by the introduction of alien organisms across the isthmus, but I do not believe that is important because the environments are too different.

GORDON GUNTER
Ocean Springs, Mississippi

An Urban View of the Opium Chain

"The Poppies Are Beautiful This Year" (February, 1972) is a particularly notable and valuable article. A great deal that happens in man's relations with nature has political implications. Your article—quite rightly—concerns itself with the flower, the harvesting and marketing of opium. This long-neglected side of narcotic usage is a particularly political subject.

While the Administration is cracking down on importations from France, opium smuggling from the Orient is not publicly assailed except by the Democrats, and if some sources are right, the Democrats were tolerant enough of the practice when they were in power. I wonder if I'm being too cynical in imagining that opium trade from Southeast Asia will increase, while France's decreases.

In any event, it has been noted that no notice was taken of the opium trade until middle-class youngsters became addicts. To my knowledge, only the Black Panthers and Black Muslims actively fought heroin before 1967, when I began work in the central city area of San Francisco. No mind was paid then, and little mind paid now, to ghetto problems.

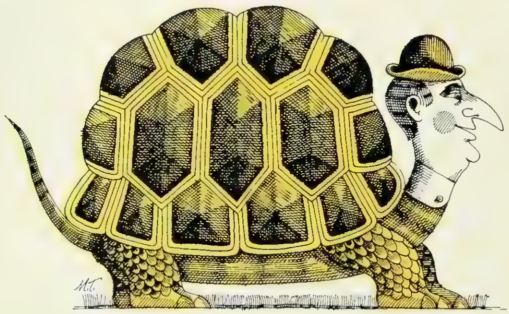
I wonder if the importation and marketing of narcotics can be explained only by adopting terms used by the radical left: the rich are exploiting not only the economic life but the very souls of the poor, who no longer gain any satisfaction in conforming to what the middle and upper classes consider socially acceptable behavior. What results is a "generation" gap, not just of age, but of politics and economics as well. Look at how drug overdoses are killing younger and younger people; look at the increasing "hippie drop-out" and the disaffection of young black, chicano, and red populations.

S. UNTERMYER, III
Brant Lake, New York

The photograph on page 30 of the article "The Poppies Are Beautiful This Year" is most certainly not an Akha woman, as indicated, but rather a Yao woman. The two tribes are completely unrelated and quite distinctive in the traditional costumes, particularly those worn by the women. I have worked for years with both groups in northern Thailand and know them well.

CAPT. JOHN H. BRANDT
Window Rock, Arizona

A Trip Through Ma Bell's Zoo



Where can you find gibbons without fleas, schools of herring but no cod? Why, in your phone book, of course, Mr. Aardvark

I have always been intrigued by the occurrence of zoonyms (animal names). Mr. and Mrs. Wolf were family friends during my childhood and I have distant cousins whose name is Lion. Later, I went to school with children named Fish and Bird and I learned to take such names for granted. The fascination with zoonyms returned when I lived in Rio de Janeiro for a time and met my first Sheep and Horse, surnames that occasion no surprise if they are translated back into Portuguese. During moments of frustration with my work, I would plan imaginary encounters between the charming Senhor and Senhora Coelho (rabbit) and the equally charming Mr. and Mrs. Beaver. The only useful purpose these daydreams served was an occasional success at the dinner table when nothing else could get my six-year-old daughter to eat her vegetables.

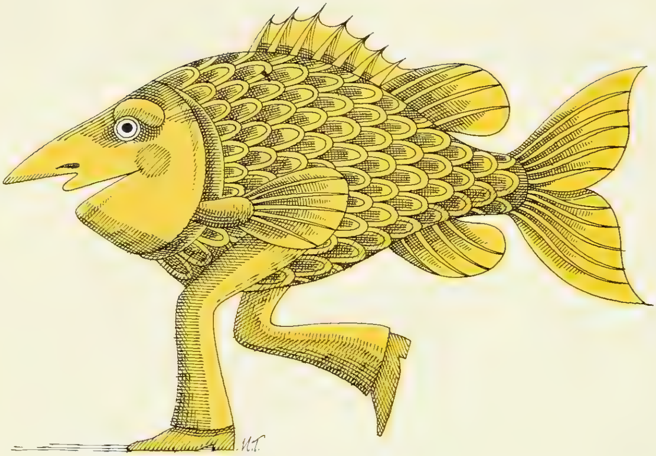
Five years ago the whole issue suddenly took on a maddening urgency. It was about then that I first met Robin Fox, chairman of the newly established Department of Anthropology at Rutgers University. One of Fox's first acts as chairman was to make Lionel Tiger a professor in the same department. Professors Fox and Tiger soon proceeded to collaborate in the authorship of a somewhat popular book bearing the title *The Imperial Animal.* Naturally, I am not about to suggest that there actually is a behavioral relationship between zoonymic humans and their animal familiars. But the Fox–Tiger problem suggests that the desultory musings that have hitherto characterized this field ought to be replaced by a more responsible form of scholarship.

To get the ball rolling, I here report on my preliminary researches into the patterns of zoonymy in the Manhattan telephone directory, 1968-69 (the only Manhattan book I could find in my Bergen County, New Jersey, residence). The first thing I discovered about English language zoonyms is that bird surnames outnumber mammal, fish follow mammals, and insects follow fish, in descending order of popularity. Turtle is the only amphibian and there are no reptiles.

To account for this lopsided inventory, we must posit the existence of some selective force. Evidently, animal familiars that, for one reason or another, developed a poor public image were either never adopted or gradually abandoned. This principle helps to explain not only why certain phyla are more popular than others but also why zoonyms are outnumbered by other kinds of names.

We may assume that European zoonyms were more common during Neolithic times than they are today. With the advance of urban life, and the ecological separation of man and animals, zoonyms were gradually replaced by names such as Smith, Potter, and Carpenter, which designated occupational specialties. Zoonyms of those insects regarded as unmitigated pests were the first casualties. Thus we find not a single flea, gnat, termite, or wasp in the Manhattan directory. The absence of snake, lizard, toad, and several other reptiles and amphibians can be explained in the same way.

Extending this principle to mammals and birds, we can readily un-

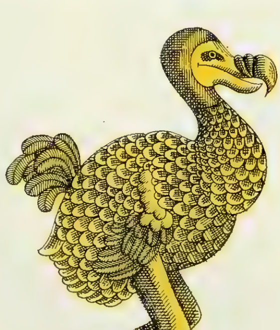


derstand why most of us have never met a Mr. or Mrs. Skunk, Rat, or Mouse, or a Mr. or Mrs. Vulture or Grackle. In fact, we can now see why birds outnumber all other animals in Manhattan. Proportionate to the total number of species, few birds can be described as unmitigated pests.

Yet there are serious flaws in this line of reasoning. Some very conspicuous pests are well represented by modern zoonyms. Among insects, both fly and roach show no signs of succumbing to vulgar opinion. As for birds, starlings can scarcely be considered less of a nuisance than grackles, yet the name Starling occurs as often as Stork, Swallow, or Finch, while Grackle is extinct. Moreover, given the suburban bird watchers' widespread prejudice against aggressive and noisy crows and bluejays, it is difficult to understand why Crow and Jay retain their popularity as compared with, let us say, Owl, Warbler, or Woodpecker, all three of which also seem to have become extinct.

There are many other aspects of the zoonymic repertory that cannot be explained merely by invoking the principle of selection against noxious species. Most animals are associated with a mixture of positive and negative attributes. On balance it becomes impossible to tell why wolf, fox, bear, and beaver are popular mammals, while bat, bison, lynx, and chipmunk are utterly devoid of human congeners (at least in Manhattan). I have pursued the possibility that despite their dangerous and destructive habits, wolf and fox are popular because they are highly social mammals with whom humans find it easy to identify. But this leads to an impasse presented by the virtual absence of man's closest collaterals—no Mr. Monkey or Ape; no Miss Gorilla, Chimpanzee, or Orangutan.

To make matters even more complicated, we do find the popular Gibbon. One might argue that the etymology of Mr. Gibbon has converged accidentally with that of gibbon the hylobatid. Otherwise, a selective principle that operates in favor of the zoonyms of highly social or manlike creatures would have preserved convergences toward the pongids and anthropoids in general.



The mystery of the absence of gorilla, orang, and chimpanzee is clarified somewhat by the fact that these are tropical species. The inventory of English-language zoonyms exhibits a marked bias against animal species that are found only in the tropics or exclusively in Asia, Africa, or the New World. Presumably, some otherwise acceptable zoonymic possibilities have been neglected simply because, until recently, Europeans didn't know they existed. Here we come to understand partially why there should be Badger but no Tapir, Seal but no Manatee, Deer but no Okapi, Elk but no Gnu, Falcon but no Condor, Shark but no Barracuda, Salmon but no Tuna, Stork but no Penguin.

At first glance, Lion would appear to be an exception, but there is evidence that lions roamed southern Europe at least as recently as the early Hellenic period. That leaves Tiger, an admittedly strictly Asian feline. Perhaps we must concede that a creature as impressive as a tiger might get a name for itself beyond its normal habitat. If so, what do we do about the elephant? Why is this most famous, beloved, intelligent, industrious, and powerful creature a zoonymic failure? Do I hear you suggesting that perhaps no one wants to be identified with an animal whose nose is so long and whose skin is so ugly? If so, we must face the fish quandary. Can it honestly be maintained that the zoonymically successful haddock is inherently more beautiful than an elephant or a giraffe? Of course, there is the important fact that fish are usually esteemed for their contribution to human diet, but even within the North Atlantic group, which provides our principal marine staples, inexplicable omissions can be found. For example, there are whole schools of Herring and Pollack, but not a single Cod or Sardine.

Among birds, the principle of dietary utility fails to make sense out of the English game bird complex. We get flocks of Partridge, Grouse, Mallard, and Woodcock, but only a lone Quail, and not a single Pheasant.

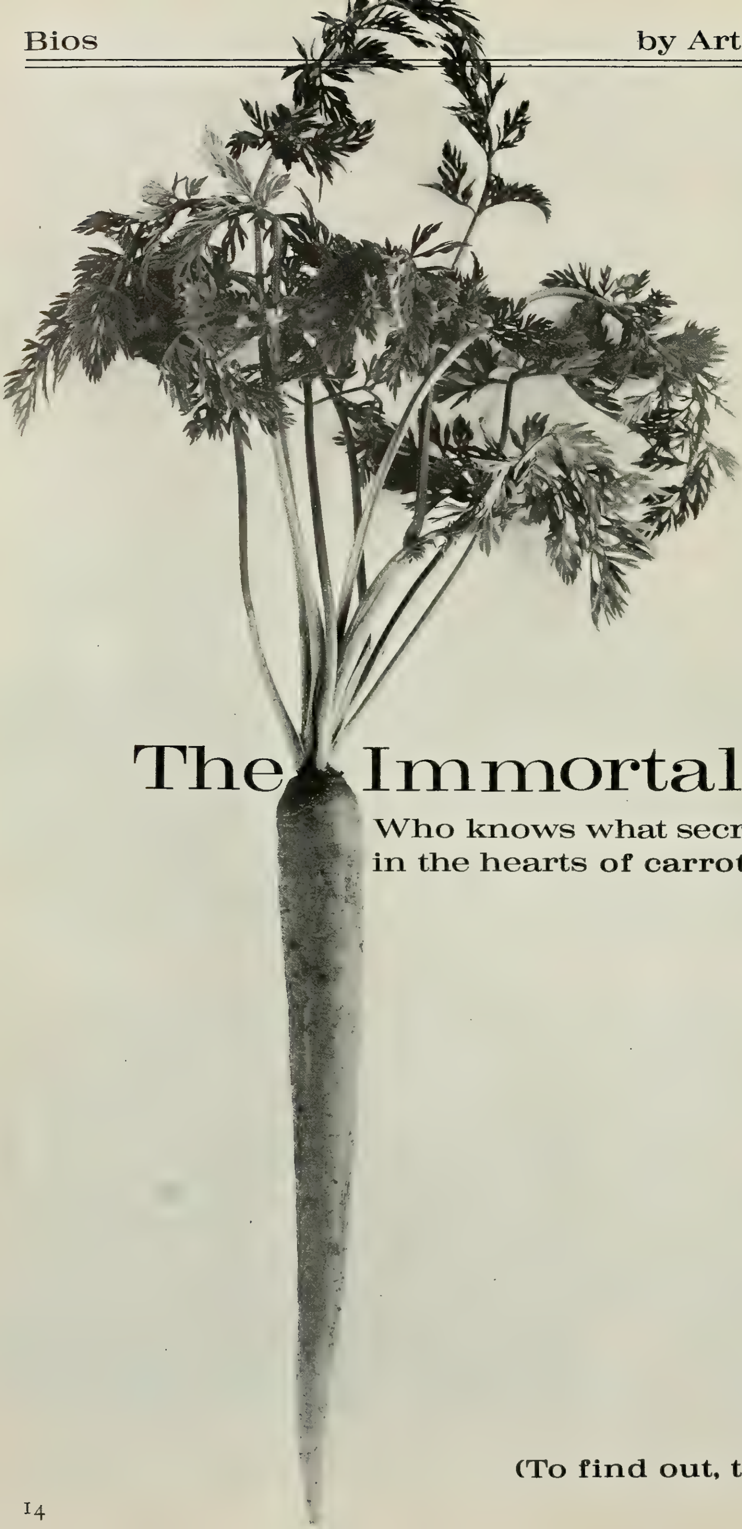
The utility principle will take you just so far and no further. It is clear that purely ornamental crea-

tures, such as minnow, goldfish, peacock, and nightingale, are zoonymically more successful than such worthy food providers as mackerel, turkey, and goose. In fact, the zoonymic failure of some of our favorite barnyard friends might even suggest that an antiutilitarian principle is at work. Have you ever met a Mr. Pig, a Miss Chicken, or a Mrs. Goat? Why do we avoid ox, mule, and horse, the very animals that have contributed most to the development of our civilization?

We are in a similar quandary with respect to cat and dog. Even in an urban environment, these faithful companions render important services, yet we apparently deem them unworthy of zoonymic consideration. We seem to be prejudiced not so much against useful animals in general, but against all kinds of useful domesticated species. Domestication seems to cripple zoonymic potential. I conclude that the basic requirement for zoonymic success is freedom from domination by human beings. What we most admire in an animal is its independence.

In zoonymy every principle begets its opposite. Further research will be required before we can be certain that we have solved the major mysteries of this domain. But it is clear that zoonyms, like the animals themselves, are endangered species. Many of the most interesting examples, like Mr. Kiwi and Mr. Dodo, are represented by sole survivors and unless remedial action is taken, all future research will have to be conducted in libraries and cemeteries.

by Arthur W. Galston



The Immortal Carrot

Who knows what secrets lurk in the hearts of carrots?

(To find out, turn to page 16)

The Immortal Carrot

The human animal, whether herbivore or carnivore, is totally dependent upon the photosynthetic activity of green plants for his sustenance. Whether we eat a spinach leaf or a beef steak, we are indirectly taking solar energy captured by the chloroplast of a green leaf and transforming it into chemical-bond energy for sustenance and growth of the human body.

One of the greatest accomplishments of agriculture is the development of high-yielding strains of plants, especially cereals. With recent knowledge of plant nutrition, of growth-regulating chemicals, and of chemical and biological control of noxious fungi and insects, man has achieved ever greater productivity per acre. The venturing of many conglomerate corporations into our highly technologized "agribusiness" shows that fantastically high capital outlays per acre under production can be justified in terms of the present high yields.

Despite these agricultural triumphs and the rosy profit projections of well-heeled corporations moving into the field, those who understand plants realize the precariousness of agriculture's present high productivity. There is a great need for experimentation in new genetic strains of plants. The corn blight in the United States and the devastating rice wilt in the Philippines show that even our most dependable strains of cereals are constantly endangered by mutating pathogens. We are in a continuous race with the fungi and insects, attempting to produce new types of plants that will yield high quantities of food and resist the ravages of pests, which could consume the crop before man harvests it.

The highest-yielding strains of plants are particularly susceptible to pathogens. Because of their rapid growth and maturation, these plants are extremely succulent and usually lack the protective devices against pests that wild plants normally have. In addition, modern intensive agriculture, with forced rapid growth of the same plant on the same soil year after year, is most conducive to the development of pathogenic organisms in the soil. As a result, modern productive agriculture has become truly dependent on a vast arsenal of chemical pesticides.

It has been the geneticist and plant breeder who have traditionally developed new strains of agriculturally useful plants. Through selection, crossing, and selection again, they have developed plant strains with desirable characteristics. In a great many cases, disease resistance from wild strains has been successfully introduced into high-yielding strains. Geneticists have also taken advantage of chance mutations, and more recently, using radiation and mutagenic chemicals, they have accelerated the creation of new strains. Whether the new strain arises by chance or is induced by chemicals or radiation, its characteristics frequently can be introduced into existing plant strains with beneficial results.

Despite these practices, many experts feel that we are in danger of losing our race with the fungi and other pathogens. For one thing, the breeding cycle of a higher plant encompasses, at the very least, several months and often several years. You cannot see the results of a genetic cross until you have harvested the seed, grown the plant, tested it, and then decided what to do in the next breeding operation. In this period many fungi will have gone through many breeding cycles, and may have produced new types, which in many instances will overcome the resistance originally bred into the crop plant.

We need faster techniques for changing plants. Several recent developments in the field of plant physiology give promise of meeting this need. While none of these procedures has become economically important yet, it seems only a question of time before a new technology flowing from these developments will yield something of major importance for man.

In the mid-1930s, two Frenchmen, Gautheret and Nobécourt, independently discovered that small pieces of tissue cut from a carrot root and put into a nutrient medium would grow and divide, apparently indefinitely. The carrot plant normally lives for only two years, pro-

Continued on page 89

The Penitentiary Seals

Reflections off Gertrude Island

Dark of night is falling on the Puget Sound of Washington. The air is heavy and quiet, the water still. I sit on a pillow of sand with my back against a log on the beach of Gertrude Island.

Suddenly the face of an old man rises from the sea, up through the water grass in a rippling of light and a shattering of blackness. Droplets run from his whiskers. Here is the visitor for whom I have been waiting, one of the company of harbor seals that rest and play, quarrel and feed in the shallows off the island. We stare at one another for a long time, the elder seal and the elder man, while a humming thread of emotion runs between us, real though invisible.

"Old seal," I think, "you speak for all the wild quick things of the wilderness. You speak for a creature world we men are losing. You are history, and we are forgetting you; when our children's children will ask for you, you will be gone." I murmur aloud and the seal drops down in a flawless motion, leaving rings of silver and black on the surface of the water.

The harbor seal is everywhere an animal of lonely places. Wary of enemies approaching by land, it haunts the offshore rocks and sandbars where it can watch the horizon and scramble for deep water at the first sign of danger. It breeds along the Pacific Coast of the United States from Alaska to Baja California; in Atlantic waters, it breeds only in Maine.

No book has been written about this shy seal, although perhaps one could be compiled now from articles published in the languages of the northern maritime nations. Such a book would tell how the seals find their food—fish and shellfish—and how even a blind individual can survive. It would tell of kindhearted people who try to raise orphan seals on a bottle, and of thoughtless people who throw coins, bottles, and other trash into aquarium pools. It would describe a rarely seen act, the mating of seals in the wild. Once, in the Shetland Islands, a naturalist looked down from a cliff 150 feet above the sea and spied the animals in pairs, copulating in the clear water.

In a lifetime of traveling along the shores of the North Pacific Ocean I had never been close to harbor seals until I was guided by a graduate student to the remarkable colony on Gertrude Island. (I reveal the name of the place for the seals in this colony are not endangered. Men and boats are forbidden within three hundred yards because the island lies within the boundaries of a penitentiary.) This colony is the last important remnant of the species in Washington; a population that has declined from 10,000 to 2,000. In nearby Oregon, the numbers have dropped from 5,000 to 500.

So in memory I am back on Gertrude Island in mid-August with student Terry Newby, who is earning a master's degree at the University of Puget Sound by probing into the life history of the harbor seal. We walk along the beach, where Terry finds two helpless newborn pups, lank as salamanders. He weighs and measures each little seal, marks it with a plastic tag for later study, then releases it to its anxious mother waiting offshore. At intervals during the day, and throughout most of the night, we hide in a tall wooden tower, or blind, where windows give us a

The Mudmen of the Asaro River

One of the Lindblad private planes

Elephant at foot of Mt. Kilimanjaro

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One of the most famous and studied seals in captivity, Dub-Dub died in February at the ripe old age of 34.

clear view of the seals as they come and go with the changing of the tides. Mid-August is a good time to be here. The females give birth in August or September to their single pup and nurse it for a month to six weeks. I photograph the tender scene of a nursing pair, mother and pup. It is a rare privilege, for the birth of most harbor seals is a private event, announced only by the gulls or ravens that wait to seize the afterbirth.

To our eyes, the seal is an awkward thing, bound up in a capsule of rubbery skin that follows the body outline to the wrists and ankles. Knees and elbows are there, to be sure, but buried deep within the body. Because man himself is long of limb, tracing his ancestry to primates who ran on the plains and swung through the forest, he is apt to think of himself as a model for the mammals. But the seal is not embarrassed by its body; the seal is built to live in a watery world, the nature of which man will never fully know. The animal is perfectly a part of its water wildness. It twists and turns, nearly touches its rump with the back of its head, shoots out

its flexible neck like a striking snake, curls into a ball and dives straight down, treads water while turning to scan the horizon, then sinks to the bottom to sleep for long minutes, holding its breath yet fully relaxed. It moves with but a murmur in the quiet sea, brushing through ribbons and vines of shining weed. Tumbled by the breaking surf, it never grows dizzy; compressed by the weight of deep water, it rises without discomfort. We marvel at the way it penetrates with ease a domain where we, unprotected by machinery, must gasp and die. We envy it for knowing the darkness, for diving down to gloomy caves invisible to our eyes.

The biology books tell us that the movements of the seal are programmed; that the animal moves by numbers coded in its chromosomes. As I sit on Gertrude Island watching it perform so gracefully, so rightly in place, I wish for a moment that I too could not will, or want, or weep.

An Indian friend, Lance Kalappa, tells me he hunted seals for food. Today, men hunt the seals of Washington for other reasons—mainly for target practice—though they say, "We kill the predatory fish-eaters to spare more fish for us." It is true that half the seal's food is drawn from resources having some commercial value, but that is not the point. I ask in rebuttal, "If you kill the seals and have

Continued on page 70

If You Were a Baboon, How Would Your Mother You Were Hungry?

New and sometimes heavy lessons for 10-year-olds

by Peter B. Dow

"What is your favorite subject?" asked the doctor absentmindedly, trying to distract his young patient as he repaired a slightly injured eye. "Baboons," the small boy replied, startling the doctor and sending a ripple of laughter through the emergency ward.

This incident, recently reported to me by a school principal, is typical of children's responses to a new anthropology-based social studies course that is gradually displacing the standard fifth-grade American history program in many elementary schools across the country. Designed from concepts originally set forth by Harvard psychologist Jerome Bruner, and developed with the support of the National Science Foundation, the program introduces ten-year-olds to recent studies in anthropology and ethology by posing the question, "What is human about human beings?"

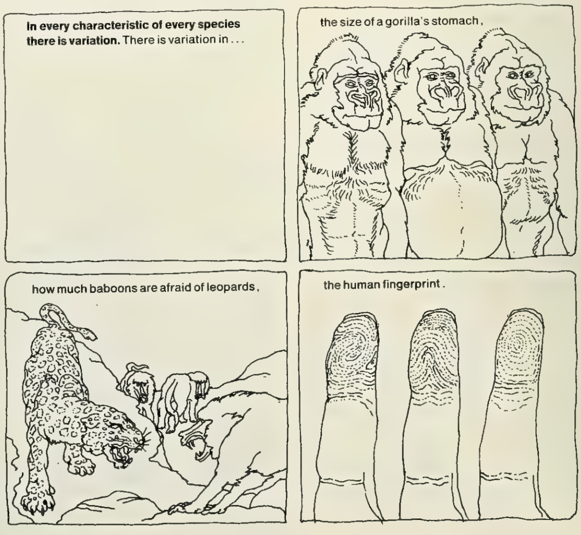
Some may argue that studies of this kind are more appropriately reserved for graduate students, but the development and testing of the course has produced impressive testimony that young children can probe deeply into questions about human behavior when new ideas are presented to them in simple and engaging forms. In fact, there is some evidence that children approach the study of human behavior more openly than most adults, for they have a spontaneous curiosity about cultural differences, and they are fascinated by comparisons between man and other animals.

To test the conjecture that young children can grapple with the mysteries of human nature in an intelligent way, we have developed "Man: A Course of Study," a year-long program of materials and strategies. Using unnarrated films, anthropologists' field notes, a variety of carefully designed booklets, and a collection of games and dramatic devices, children have been introduced to several animal studies (salmon, herring gulls, baboons, and chimpanzees) and a prolonged investigation of a traditional hunting society (the Netsilik Eskimo).

These materials extend children's exposure to ideas about human behavior well beyond their immediate experience, offering them a way to gain new perspectives on their own behavior. The extensive use of unnarrated films, free from the intrusion of authoritative commentary, provides children with opportunities to explore behavior "first-hand." They quickly learn to look for significant details and to generate questions about what they see. By contrasting these insights to the behavior they see around them, children are able to deepen their understanding of the social world in which they live.

"What are the most important events in a human lifetime?" This question, posed early in the course, takes students quickly to some of the central concerns of "Man: A Course of Study." From bits of cardboard and lengths of string, children fashion life ropes, marking off what they feel have been the most significant moments in their own lives. They then compare these events, pooling experiences to create composite lives and discussing what is universal in a typical lifetime. Why are birthdays and Bar Mitzvahs so important? What changes make a difference in the early years of a person's life? How do different lives relate to each other? What about siblings, friends, parents, relatives? What are the important relationships that develop between people at different stages of their lives?

After exploring the contrasts and continuities that exist across different human lifetimes, children are presented with the life cycle of the Pacific Coast salmon. Through films and readings, they examine the salmon's life story, beginning with the struggle of the powerful adults as they dramatically fight their way upstream through nearly impassable waterfalls to the protected waters of their ancestral spawning grounds. Here male and female, weak from



You Tell

hunger and exhausted from their ordeal, breed and die. When the eggs hatch in the spring, another generation begins the same cycle.

Children are intrigued to discover a species that can survive without the aid of parents. "How," they ask, "can an animal learn what he needs to know without an adult to teach him? How does he manage to stay alive? How can he find his way back to his birthplace after five years?" These kinds of questions lead teachers into discussions of innate and learned behavior, and the process of natural selection. The children learn about experiments that showed that the fish "memorize" the scent of the streams in which they were born, and actually smell their way back home at the time of spawning.

The survival cost that results, at least in part, from the lack of parental care among salmon elicits great amazement in children. Of the six thousand salmon eggs laid, only about two salmon survive to reproduce—very few salmon ever die in their ancestral birthplace. Is it true, then, that parental care is one of the distinctive human features? What difference do parents make?

Children are fascinated by the topic of parental care, and the program pursues it in greater depth through the study of herring gulls. Here children encounter a species that appears, at first, to be somewhat more "human" in its social organization. Male and female gulls typically mate for life, their young pass through a long period of dependency (perhaps a quarter of their lifetimes), and the nearly helpless chicks are intensively cared for by both parents during the early months of life. Children are surprised to discover, however, that much of this caring behavior is innately programmed, and that chicks must peck at their parents' beaks to activate the urge that causes the parents to regurgitate food for them. Another fact of gull life that

interests children is that the rapidly growing chicks must learn to duck their heads in the presence of their parents to avoid threatening them, for parents can easily mistake their young for other adults. Comparing the gull situation to their own, children can ponder the flexibility that exists in human parent-child relationships and discuss the many alternative child-rearing patterns that such flexibility allows. "What kind of parent is a successful parent?" is a central question of the herring gull unit.

The parallels to human behavior that some children see in the gull study lead to some interesting discussions of what human children have to do to keep their parents looking after them properly. One of the classroom exercises involves a role play in which children are asked to empathize with the limited relationship a gull has with its parents by pretending that they are herring gulls trying to get food. They then compare this to human situations. During an early trial of this analogy we learned, to our surprise, how difficult it was for some children in Newton, Massachusetts, to get a cookie. ("Have you done your homework? Did you clean your room?") Some children clearly felt that herring gulls would have an easier time of it.

The baboon is introduced to the children as a way of helping them think about the structure and behavior of a more humanlike social group. After observing an unnarrated film about animals in Amboseli Park, Kenya, and reading about the baboons and other animals that inhabit the African savanna, the children construct environment boards of their own design that simulate the region's ecology. They then place mock troops of baboons on these boards, arranging them in formations that they think will best meet the basic needs of the various troop members: access to food and water, care of the weak and the young, and protection from predators. This exercise sometimes leads to vigorous debates about what an appropriate social structure might be. Then, using materials based on Sherwood Washburn's and Irven DeVore's study of savanna baboons,

To Be a Herring Gull

by Jesus Medramo, 5th grade

Well here I am in an egg being ready to hatch. When I got strong enough I broke through the egg shell. When I got out around me sat, a huge and different world, I called for my mother and asked her where I was, but she didn't answer. I then knew where my territory line was. I was hungry just then I felt an urge to peck at the red spot and I got food. As I walked around the nest I saw other birds flying by, I just couldn't stand and watch them fly I had to try but it did no good I was to small. All I could do all day was eat and play. As time went by I had two brothers Jose and Raul, "Jose did you sleep well" and he said "Yep" but I said I didn't because I was too busy thinking about flying. Everytime my mother went by I ducked my head because I didn't want to get beat up. I was older now and one day I saw a Girl gull flying by and she said "Come on, lets fly around honey." I couldn't refuse a nice looking chick like that so I tried real hard to fly then suddenly I saw my feet lifting from the ground a new feeling got into me, at last I could fly! I was full of joy to feel how wonderful it was to fly I carved I dived and I did the summersalt. Then I started flying with the other birds in groups. Then one day my mother told me "son you are old now and must find a mate." But until I could find one I caught my own food and flew with the other birds. One day I landed right beside a female, I looked her straight in the eye then I waited no time in making my neck swell and regergitate for her as she turned around I quickly jumped on her back I knew this was the way to reproduce. After a while we found our territory and started building the nest. I said to myself soon I'll be a father. I waited a long time to be a father then one day a chick hatched and I said "I wonder what your life will be like."

children examine the actual social structure of a particular troop of baboons and compare "nature's solution" to their own formulations.

Lacking language, and dependent for communication on a repertoire of about two dozen sounds and gestures, baboon troops are held together by a dominance hierarchy headed by three or four central males that cooperate to keep order in the troop, control access to females, and provide defense against predators. This simple social structure is a provocative model for thinking about the organization of informal human social groups, and it is not surprising that children see analogies to baboon behavior in their own lives. By ten years of age, children are remarkably astute observers of the power relationships that govern their contacts with other children, as well as with adults, and discussions of successful behavior among baboons can turn into frank exchanges about what sort of behavior works in the classroom, on the playing fields, and even at home. Such discussions must be handled with honesty and sensitivity by teachers, but children can find them a refreshing change from the moralistic pronouncements that often accompany discussions of behavior in school.

Child rearing, rather than mere parental care, is another topic that emerges during the study of baboons and is of considerable interest to children. Baby baboons are born even more helpless than gull chicks, and to survive they must cling to their mothers' bellies during the first few months of life. By four months or so, they have learned to ride in a jockey position on their mothers' backs, a perch from which they can observe a wider world without facing its dangers. Weaning begins a few months later, at about the time their fur changes from black to the tawny brown of the older animals. For the young male in particular, this means rejection by his mother of both her companionship and her breast. She will often chase him if he attempts to ride, and he now seeks out closer relationships with his peers and with the dominant adult males of the troop. Many dominant males develop close attachments to the older infants, and

Continued on page 72

The Fierce and Erotic Gods of Buddhism

"It is quite sufficient for thee to know that these apparitions are the reflections of thine own thought-forms"

Bardo T'odol (Tibetan Book of the Dead)

by Carin Burrows

For several millennia Judeo-Christian religions have propounded the idea that monotheism represents the ultimate religious insight of mankind, and that spiritual understanding has proceeded from primitive animism through pagan pantheism to a final realization of the one godhead from which all things flow. Other notions of deity are regarded as primitive or superstitious. It is something of a shock, then, to discover that many people—of very ancient, sophisticated, and erudite cultures—follow a Buddhist system of belief, which contains hundreds, even thousands, of deities.

Buddhism originated in India in about the fifth century B.C. It was an iconoclastic, antiestablishment religious movement, rejecting the elaborate structure of ritual and sacrifice of Vedic Hinduism, which perpetuated the caste system of the Aryans. Buddhism appealed to the have-nots in society, many of whom were illiterate.

The Lamaist form of Buddhism, which developed in Tibet, has a pantheon of at least 7,000 deities. Because every individual theoretically has the opportunity to achieve enlightenment and to become a Buddha, the ancient religion could have an infinite number of deities. Buddhists, recognizing that men vary in disposition and level of development, say that Gautama Buddha, out of his infinite compassion, teaches the religion to each man according to his intellectual and spiritual capacities. Thus for individuals in search of enlightenment, there are different doctrines and deities.

As Buddhism evolved over the centuries, many different sects arose. Not only was Gautama deified, but many other deities came to be worshiped as well. Some were newly created personifications of abstract concepts; others were former Hindu gods, older non-Hindu gods of India, local nature deities, and saints, heroes, kings, and church hierarchs.

An actively proselyted religion, Buddhism was necessarily syncretistic, absorbing gods of other religions and regions. Followers believe, for instance, that the Indian pundit Padmasambhava, in the course of his Buddhist teaching and missionary efforts in Tibet in the eighth century A.D., conquered native gods and demons, forcing them to serve and defend Buddhism.

The greatest number of deities in the Tibetan pantheon owe their origin to Tantric doctrines and practices. Tantrism is an elaborate system of theurgic practices, yogist dis-

The personal pantheon of the Changcha Hutuktu, the Grand Lama of Peking, was painted on three t'angkas, *or scroll paintings, each containing 100 deities.*

Lha-mo is the chief guardian goddess of the Tibetan Buddhist pantheon. She is the main protectress of the so-called Yellow Hat sect, of which the Dalai Lama is the head. In one of her incarnations, Lha-mo was the wife of the king of the Yakshas in Ceylon. She vowed to convert her husband to Buddhism or else to wipe out the royal race. When she could not influence her husband, she flayed her son alive, drank his blood, and ate his flesh. The enraged king shot an arrow at his fleeing wife, which pierced the haunch of the mule she was riding. She pulled out the arrow, saying, "May the wound of my mule become an eye large enough to overlook the twenty-four regions, and may I myself extirpate the race of these malignant kings of Ceylon." In the painting, right, she sits on the skin of a human, holding a skull cup filled with blood in one hand and brandishing a staff in the other. With bared fangs and flaming hair, she rides over a sea of blood. In her peaceful form, left, Lha-mo is the principal guardian goddess of the Tibetan capital of Lhasa. The paintings that accompany this article are from three t'angkas *made for the Grand Lama of Peking in the eighteenth century. The 300 deities in the* t'angkas *are popular with followers of Lamaism, a form of Buddhism that developed in Tibet.*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དཔལ་འཁོར་ལོ་སྡོམ་པ་ཡབ་ཡུམ།

Vajradakini is one of a class of female divinities who function chiefly as consorts of the tutelary gods of Tantric Buddhism. She represents the inspirational impulses of consciousness, which can lead to knowledge and understanding. A central principle of Tantrism is a belief in the power of salvation possessed by female energy worshiped in union with its male counterpart.

Samvara is one of the chief Tantric deities. He is thought to be incarnated in the Grand Lamas of Peking. These multilimbed deities are nearly always shown in sexual union with their female consorts (Shakti). Their union symbolizes the transcending of the seeming polarities of nature—good and bad, sacred and profane, sensual and spiritual—which are seen as but two aspects of one reality.

Milaraspa, a revered Tibetan poet-saint, died in 1135. His songs and poems are widely known throughout Tibet, and pictures of him can be found in many homes. Having mastered the yogic art of hyperpyrexia, he could raise his body temperature at will and wore only a light cotton garment in the extreme cold of Tibet.

Gautama, who lived from about 560 to 480 B.C., is the fourth Buddha. There are supposed to have been three major eras, or kalpas, before the present one. A mortal Buddha, presided over each era in order to teach mankind the doctrine. The fundamental nucleus of Gautama's doctrine was the goal of liberation from the cycle of rebirth. If one attained enlightenment in this lifetime, he could achieve nirvana—the transcendence of all individual, earthly concepts. The individual would then be outside the forces that lead eternally to re-existence. The nature of the required enlightenment is described in the "Four Holy Truths": the existence of sorrow, the origin of sorrow, the conquest of sorrow, and the way of the conquest of sorrow (the Eightfold Path). The person who reached this goal was called an arhat, or venerable one.

Maitreya is the fifth, or coming, Buddha. He is waiting in the Tushita Heaven for the time when he is to appear on earth as the Manushibuddha of the fifth world-cycle. In the pantheon of the Changcha Hutuktu, a form of Buddha is depicted at the top of each of the three panels. Ninety-nine other deities appear in small squares beneath each Buddha. By the time Buddhism reached Tibet in the eighth century A.D., it had undergone many modifications. The arhat ideal had changed to that of bodhisattva. A bodhisattva is a saint who could gain nirvana for himself, but who voluntarily remains within the cycle of rebirth until such time as all beings are set free. He is therefore a future Buddha dedicated to the salvation of all. This expanded doctrine is called the Mahayana, or "great path," as against the older Hinayana, or "little path."


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ཆོས་རྒྱལ་ཕྱི་སྒྲུབ་ལ་ན་མོ། །

ciplines, and mystic rites set forth in a large body of writings called Tantras. Tantric Buddhism is a highly esoteric discipline, traditionally reserved only for the initiate and handed on from master to pupil by oral tradition and secret texts. Some of these texts are beginning to reach the Western world, but without a teacher, or guru, they are difficult to master.

A central principle of Tantrism, and one that has led to much criticism from non-Tantrists, is a belief in the power of salvation possessed by the female energy (Shakti), which is worshiped in union with its male counterpart.

The Tantras created elaborate systems of deities and grouped them into families, some of them emanations of others and all of them having more than one form. The deities were assigned different colors, companions, and expressions according to their function in different rites. A god invoked to heal the sick or vanquish an enemy or to bring prosperity will have a different appearance for each role.

It is among the Tantric deities that we find the classes of gods that seem most strange from a Western point of view: the terrible gods, the erotic gods, and the group of deities with multiple heads, arms, and legs. The terrible gods are depicted in malignant and threatening form, with ferocious mien and horrible attributes—crowns of skulls, flayed human skins, human skull cups filled with blood, belts of severed human heads—while the erotic gods, often ithyphallic, are frequently shown in sexual union with their partners.

There are differing explanations, even among the Tibetans, for the curious nature of these gods. The terrifying deities are called Protectors of the Faith (*dharmapala*), and their frightful aspect is designed to frighten and repel the enemies of Buddhism. For the faithful, they are powerful guardians against harm. Some terrible deities are said to have been local demons who have sworn an oath to support Buddhism. These are known as *dam chan*, an example of whom is rDo-rJe legs-pa, shown on the cover of this magazine.

The *Bardo T'odol* (the Tibetan Book of the Dead) gives a different reason for the existence of these gods. During *bardo*, a forty-nine-day period after death, the soul encounters visions and experiences that lead either to enlightenment and release or to rebirth. In preparing for this ordeal, the individual is advised that "by having meditated on the description of these blood-drinking deities while in the human world, and by having performed some worship or praise of them, or, at least, by having seen their painted likeness and their images . . . recognition of them will result and liberation."

The erotic deities symbolize the transcendence of apparent dualities, the fundamental oneness of the cosmos. They embody the goal of Yoga: the commingling of the individual soul with the highest spirit, or universal soul. The highest spirit is an inexhaustible storehouse of energy. Therefore, in Yoga the chief aim of an individual is to commingle with

Yama, the Lord of Death, is mythologically of Hindu origin. Brought before him, the wicked are questioned, judged, and taken by demons to their punishment. The deity is often accompanied by his sister, Yami, who stands on the bull's flank and holds a skull cup of blood to Yama's lips.

this spirit, to become one with this fundamental energy, thereby renewing oneself and experiencing indescribable joy.

The gods shown with a multiplicity of heads and limbs are said to be portrayed in this manner to express the magnitude of their powers, and to connect the god with all the attributes assigned to it. They may also represent syntheses of systems of deities.

The beauty and power of Buddhist art objects from Tibet are self-evident. These art forms may communicate something of the aspirations common to all mankind, for they were designed to reach unconscious psychic centers, which perhaps are fundamentally similar in all humans. The same visual symbols (such as the cross, the swastika, the eagle) have been used by many religions at various times and places, although their meanings have changed profoundly.

Although some of the power and meaning of Tibetan art can be understood intuitively, a study of Buddhist philosophy will unfold deeper meaning. Since one purpose of these works was to teach religious doctrine in visible form, a standardized artistic language arose. A visual language requires stable iconographic systems, and a large body of Buddhist literature is devoted to descriptions, correct measurements, and canonical formulas for depicting the deities. The figures are identified mainly by their body positions (*asana*), hand gestures (*mudra*), colors, and the objects they hold or support.

Many of the different forms of a deity were originally visualized by Tantric Yogins during intense meditation—a state similar to that of deep sleep, except that the individual maintains an awareness of the communion of the soul with the highest spirit. While in this state, the Yogin sees a particular form of the deity, which is then communicated to his pupils so that they can easily and quickly visualize the deity and attain the supernatural powers connected with its worship. Thousands of Yogins have visualized innumerable deities, comparing them to the sparks coming out of the divine spirit, or the universal energy.

The highest degree of intellectual power is necessary to follow the path of Tantric Yoga, and it cannot be, and in fact, never was, meant for all. The practices must be conducted on right lines, under the guidance and control of an expert, for mistakes in the process may bring incalculable harm to the practitioner. The Tantrics say that the practice of Yoga is like playing with high-voltage electricity, and carelessness may cause suffering or even death. It is for this reason that we find among the Tantrists a great reverence for the guru; without an expert, the Yoga path is impossible to follow.

Historically, wherever Buddhism spread, its art forms went with it. Images and paintings were considered essential aids to the practice of the religion. Today, the growing interest in Tibetan art in the West may be followed by an appreciation of the thought system it expresses—a system that seems to offer an enlargement, an enrichment, of traditional Western ideas about life and death, the nature of satisfaction, and the path to its attainment.

In my study of Buddhist art, I have begun to see the experience of meditation on, invocation to, and contemplation of, the image of a deity as a creative act of individual will. Behind this whole interconnected experience is the individual's determination to achieve identification with ultimate ideals. "Deity" consists of man's search for deity.

Garuda is a part-bird, part-human deity who is worshiped by Hindus and Buddhists, as well as by the followers of Bon, the pre-Buddhist religion of Tibet. He is an ancient deity, associated with the widespread symbol of the solar eagle.

The Endless Race of Life

Predators of the Serengeti: Conclusion Without the blundering hand of man, the Serengeti animals form an elegant system of checks and balances

by George B. Schaller

The Serengeti is a boundless region with horizons so wide that one can see clouds between the legs of an ostrich. It is a Pleistocene vision throbbing with the life of more than half a million wildebeest and zebra, a stern yet lovely wilderness where man can renew his ancient ties with the predators that were once his competitors and the prey that gave him sustenance.

Tanzania possesses in the Serengeti one of the great parks of the world. The aim of the Tanzania National Parks is "to conserve the present variety of the different habitats within the Park and of the different species of fauna using these habitats and to maintain them as nearly as possible in their present distribution and proportions." But conservation alone may not be sufficient to accomplish this objective, for the park is not a self-contained unit. Wandering freely back and forth across its borders, the wildebeest and zebras are coming into increasing conflict with agriculturists and pastoralists, so much so that the huge herds may some day have to be managed.

Any scheme that will tamper with the hoofed animals will automatically involve consideration of the predators, for the interactions between these animals help determine their population levels. The various prey species all have antipredator patterns, but their responses to a predator are so finely balanced—between the need for avoidance and maintenance of a status quo; between an animal's attempts to defend a member of the group and efforts to save its own life—that the adaptiveness of these patterns is not always apparent.

Prey animals, however, know the potential of each predator. A gazelle, for example, has the smallest flight distance in response to a jackal and progressively larger ones in response to hyenas, lions and leopards, cheetah, and finally wild dogs, which generally are avoided as soon as a pack moves into view a half-mile or more away. The flight distance is correlated with the danger that each of the predatory species represents.

Wildebeest and zebra may permit wild dogs and cheetah to approach to within 20 yards or less without fleeing, whereas a lion is usually avoided at 50 yards. If, however, the herd contains vulnerable young, it may retreat when these predators are more than 100 yards away. Wildebeest and zebra are quite casual about the proximity of hyenas, permitting approach to within 10 yards or less. The animals can probably detect from the hyena's behavior whether or not it is hunting.

The defensive actions of the prey are also adapted to each predator. A female Thomson's gazelle may butt a jackal vigorously when defending her fawn, but against a hyena she limits herself to distraction displays, and with other predators she makes no effort to save her young because she herself may be killed. Wildebeest and zebra sometimes defend their offspring against cheetah, wild dogs, and hyenas but not against lions. Buffalo and rhinoceros readily attack lions when their young are threatened. If the prey outweighs a predator by a ratio of at least 3:1, then it may feel secure enough to attack.

Defense of young is usually limited to the mother. Among zebra, however, several mares and a stallion may attack a predator. A communal effort is particularly evident among buffalo, and a solid phalanx of horns will sometimes greet a lion in search of a meal. A cohesive social unit seems to promote communal defense.

Although an animal occasionally defends its young against a predator, it usually does nothing to defend itself once it has been caught. It is surprising that horns and teeth, which are consistently used as weapons in intraspecific strife, are wielded only infrequently by an animal in defense of its life.

Wildebeest line up to watch a lion pass. If the predator is in sight, the wildebeest are safe because they can run faster than the lion.

Some antipredator patterns probably evolved in response to a particular hunting style. To escape from a stalker, for example, a gazelle needs only a moderate running speed, but a much greater speed is required to elude a courser, such as the wild dog. Other patterns for deterring coursers include the bunching of herds, a zigzagging run, and the retreat of young to the center of the herd. Several antipredator devices relevant mainly to stalkers include the tendency of animals to stay away from dense cover, to drink in daytime, to travel in single file, and to scatter and jump with twisting leaps when they are attacked.

Most prey species can run at more than 40 miles an hour. With a top speed of about 35 miles an hour, a lion has to be close to its quarry before a surprise rush can have much chance of succeeding. A visible lion is a safe lion, and the prey animals know this. They may line up at a distance of 120 feet to watch a great cat walk by and afterward may even follow it. At waterholes most prey are always poised for flight, having learned where danger lurks.

The fleetness and alertness of prey are products of constant predation that has weeded out the stolid and slow. There is a continual evolutionary race between predator and prey. As a prey species develops some slight advantage in its race against death, a predator promptly finds a way to overcome it. But it is a race that can have no winner.

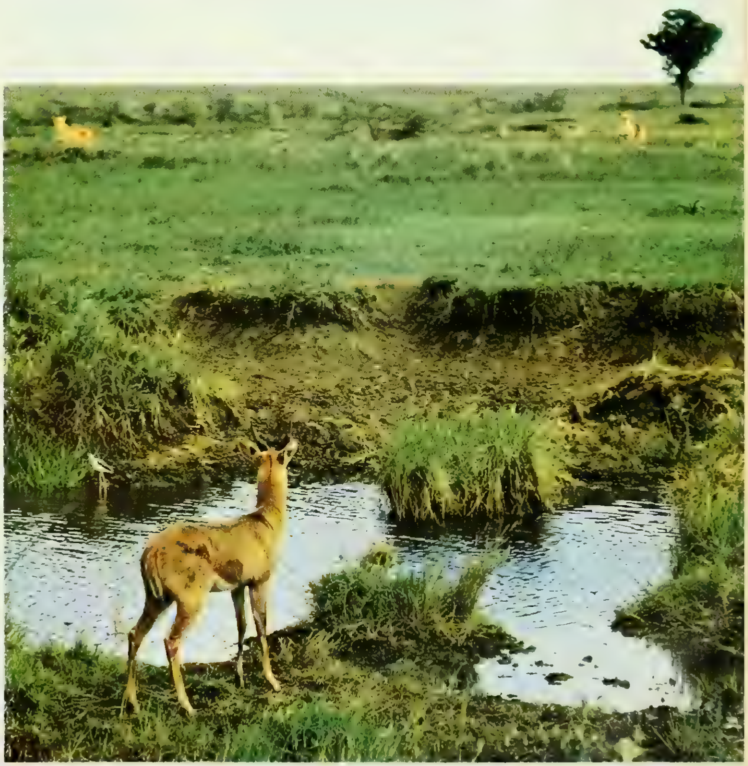
The need to avoid capture must be weighed against the other daily requirements of the animal, such as a supply of green forage, which it may be able to obtain only by migrating, entering thickets, or in other ways that make it vulnerable.

Predators are generally more successful at catching small young than adults, and a large proportion of the diet of several species consists of such animals. It has been speculated that birth peaks, which are typical of most Serengeti ungulates, represent an antipredator mechanism that makes young so abundant for a short period that all predators become satiated, only to have few or no young available during the rest of the year. Other scientists hypothesize that climatic factors, specifically the growth of nutritious green forage following the seasonal rains, affect the birth season of some species.

A strong case can be made for the argument that the births of most species are timed in such a way that the young will have good forage available at a critical time in their development. But it seems likely that predation influences the magnitude of the peak in those species in which the young are particularly vulnerable either because they are conspicuous or the social system does not adequately provide for their protection. For example, hyenas, wild dogs, and cheetah all select newborn wildebeest calves, making those born early and late in the season highly vulnerable. Predation in this case maintains the sharp birth peak.

By observing predators continuously for several days at various seasons, it is possible to obtain an idea about how much food they ingest and how often they kill. The predators removed roughly 9 to 10 percent of the estimated prey biomass. A critical question is to what extent these animals represent a surplus destined to die anyway. I estimated the amount of prey killed and scavenged annually by several predators in the Serengeti, and Dutch scientist Hans Kruuk did the same for hyenas. At best, the figures represent only the right order of magnitude:

Wild dogs, above, chase a herd of zebra on the Serengeti. The dogs usually chase a herd only long enough to find out if one of the prey is weak and vulnerable. At a waterhole, right, an antelope alertly watches some distant lions.



Estimated Pounds of Prey Killed and Scavenged Annually

Lion	10,881,000–13,057,000
Hyena	7,242,000
Leopard	1,587,000– 2,381,000
Cheetah	824,000– 995,000
Wild Dog	402,000– 604,000
Total	20,936,000–24,279,000

Wildebeest. Thousands of wildebeest calves die each season—one scientist estimated that 59,840, or 45 percent, of the calves died in 1966—but predators account for only part of this loss for several reasons. First, wildebeest have a sharp birth peak, making small young available for only a few months; second, traveling en masse, the pop-

ulation reduces the general availability of calves; and third, calving on the plains has reduced lion and leopard predation on newborn young to a negligible amount. While predators do kill many calves, the loss is so great that other mortality factors must also be operating. Hyenas remove from 5,592 to 9,286 yearlings and adults annually, roughly 1.7 to 2.8 percent of the population. The estimate includes many sick and starving individuals, as well as those dead from one cause or another. Thus hyenas harvest a large proportion of surplus animals. Lions, which have wildebeest available for about one-third of the year, kill an estimated 9,139 to 13,710 animals (including calves), or 2.2 to 3.3 percent of a recent year's population of 410,000. While lions kill many healthy adults, they also account for a significant number of animals in poor condition and other surplus individuals.

Predation by itself has little impact on the population. Many thousands of individuals die from other causes each year, most probably from a combination of malnutrition and disease. That the number of wildebeest has increased dramatically in recent years is the most potent argument in support of the statement that predation is not an important limiting factor.

Zebra. With no information to the contrary, I assume that the population of about 150,000 animals remained stable during my study. Hans Kruuk calculated that hyenas accounted for the death of 4,750 to 6,271 zebras annually, or a total of 3.2 to 4.2 percent of the population. At least a few zebras are available to most lions for two-thirds of the year, and my guess is that about 30 percent of their food consists of this species. It is difficult to determine to what extent these percentages represent an expendable surplus. Two-thirds of the foals disappear within the first few months of life, probably from disease and malnutrition. Many adults that are killed by hyenas are undoubtedly in poor condition, as are some of those that are taken by lions; in addition, both predators find and eat zebras that have died. Predation seems to act as a limiting factor, but disease and possibly malnutrition also depress the population, keeping it from fluctuating markedly.

Thomson's Gazelle. Gazelle have a higher reproductive potential than any other main prey species. Many females have young twice a year and most yearlings probably give birth at least once. Only an estimated 2.5 percent of the lion's prey biomass consists of gazelle. One-third of the total kill of wild dogs probably consists of gazelle, 45 percent of it fawns; and for cheetah the respective figures are 60 and 66 percent. Jackals and other small predators catch many young. All large predators, with the possible exception of hyenas, kill seemingly healthy adult gazelle, and this, together with the total number taken, suggests that predation may be an important limiting factor on the population.

Buffalo. An estimated 15 percent of the prey biomass taken by lions consists of buffalo. This amounts annually to 1,762 to 2,115 buffalo. According to one estimate, 6,300 yearling and adult buffaloes die each year, indicating that lions account for only about one-third of this total. Disease is possibly a major cause of death in calves and malnutrition in adults, and these two factors affect the Serengeti population more than predation. The population has been increasing steadily in recent years, a further proof that predation is inconsequential.

To sum up, wildebeest and buffalo have been increasing steadily, probably as a result of improved range conditions after successive seasons of good rain distribution, coupled with a reduced incidence of disease. The Thomson's gazelle, zebra, and eland populations have probably remained stable or at least have not fluctuated markedly. Wildebeest and buffalo escape the full impact of predation, the former by migrating and the latter by being large. The remaining species are both available and vulnerable to predation throughout the year, and the evidence, although limited, indicates that this is a factor in keeping their populations depressed.

Under normal circumstances it seems unlikely that an ungulate species in the Serengeti can draw enough predation pressure to depress it below its threshold of security. But predation can hold species below their carrying capacity, below a level at which disease, starvation, and other regulatory forces associated with poor nutrition can take effect.

Wildebeest and buffalo may have reached the carrying capacity of the Serengeti, and drastic forces may ultimately reduce their numbers. The most important influence of predation is a dampening of the tendency of ungulate populations to increase beyond the carrying capacity of their range.

The Serengeti predators are an integral and essential part of the ecological community. They help maintain an equilibrium in the prey populations within the limits imposed by the environment, thus preventing severe fluctuations in the number of animals and condition of the habitat. To this task they bring a discernment that cannot be matched by man: predators are the best wildlife managers. It is not coincidental that species such as the elephant, which have somehow escaped the effects of predation, pose the greatest management problems in reserves.

The predators weed out the sick and old; they keep herds healthy and alert. The beauty of antelope, their vital tension, fleetness, and grace are the evolutionary products of a constant predator pressure that has eliminated the stolid and slow. Man, one hopes, has gained enough wisdom from his past mistakes to realize that, to survive in all their vigor and abundance, prey populations need the lion and other predators.

To proclaim territory, male topi stand on anthills. This behavior helps them spot lions, which usually fail to stalk them successfully.

At the Creation

by John P. Wiley, Jr.

Don't Bet Everything on the Big Bang

For those of us brought up to believe in some kind of divine creation, the big bang theory of the universe has been comforting. It postulated that "in the beginning" a fantastically dense ball of energy blew up, leaving the present universe as its still scattering remains. That great ball of fury sounded very much like the work of a creator. I recall feeling a pleasant twinge of recognition on learning that cosmologists could not start their account of the beginnings of the universe at time zero, but had to start after 10^{-44} seconds had elapsed. Admittedly, that first .00000000000000000-000000000000000000000000001 second of the history of the universe did not last long, but it seemed long enough to leave what happened at time zero an open question.

The big bang theory was also comforting because it placed creation at a great distance in the past, at least 10 billion years ago and more likely 20 billion. True, phenomena such as life on earth arose much further on, but if the cosmologists could explain whole galaxies by invoking simple differences in the density of the primordial ball, then I could invoke a few key inhomogeneities in whatever it was that preceded matter to explain the subsequent chemical evolution in stars and galaxies, which in turn made it possible, perhaps unavoidable, for life to arise. All of creation could have been accomplished in one glorious stroke.

Today the big bang theory is the conventional wisdom. It is the "continental drift" of astronomy, only more so. And yet not everyone is convinced. Geoffrey Burbidge is a leader of the loyal opposition. Citing a long list of reasons, he finds the big bang difficult to accept and argues for a very different cosmology, the steady-state universe, a theory associated primarily with a group of British astronomers. To retain the same density of matter in a universe that is clearly expanding, the theory provides for continuous creation of matter. True, it works out to only one hydrogen atom per cubic foot of space every couple of billion years, but that is still matter popping into being out of nowhere, all the time and all around us. If the steady-state people turn out to be right, it would mean that creation is still going on.

(The true story may be even more dramatic. Recent speculation suggests that matter in our universe is disappearing into the fantastic gravitational wells of black holes, only to appear in other universes through what appear to be "white holes." Our white holes may be the quasars, whose prodigious energies we are currently at a loss to explain.)

While Burbidge clearly prefers the steady-state theory, he is not yet prepared to say it is correct. What he is prepared to say is that it is far too early to assume that the big bang is right. Writing in *Nature*, he suggests that modern cosmology is influenced by several factors, including "new observational discoveries combined with an extremely simple-minded approach to them, a deep-seated conviction by many that general relativity is correct in all details, a belief that astronomy has nothing to teach us about fundamental physics, and, last but not least, a deep-seated hostility by both observers and theoreticians in the astronomical community toward the steady-state theory."

He concludes, "Was there really a big bang? I believe that the answer clearly must be that we do not know, and that if we are ever to find an answer, much more effort must be devoted to cosmological tests, with a much more open-minded approach, and that much more original thinking must be done to attempt to explain the large amount of observational material, and not only the material that can be used in a narrow sense to fit preconceived ideas."

Postscript to the Jupiter Mission Along with scientific instruments to gather information and send it back to earth, Pioneer 10 is also carrying greetings to whatever extraterrestrial civilizations it may encounter. Etched on a six- by nine-inch plate are diagrams of the energy states of hydrogen atoms, the location of the earth relative to 14 pulsars and the center of the galaxy, a schematic of the solar system showing the space probe flying from the third to the fifth planet and then being hurled into interstellar space, and a man and a woman (the man has his hand up in friendly greeting) against a diagram of the Pioneer, indicating their relative sizes.

Frank Drake and Carl Sagan at Cornell University designed the plate. Both have long dreamed of finding and communicating with intelligent life elsewhere in the universe. More than a decade ago Drake conducted the first search for radio signals from other worlds. Trying to anticipate what sort of message he might receive, Drake first devised a message that could easily be sent and understood by the recipient despite presumed differences in language, culture, and physical shape and size. The message was a series of zeros and ones; when arranged in the proper rows with a blank square for a zero and a filled square for a one, the message became a picture representing a man, woman, and child, the solar system, and a number of physical constants and relationships.

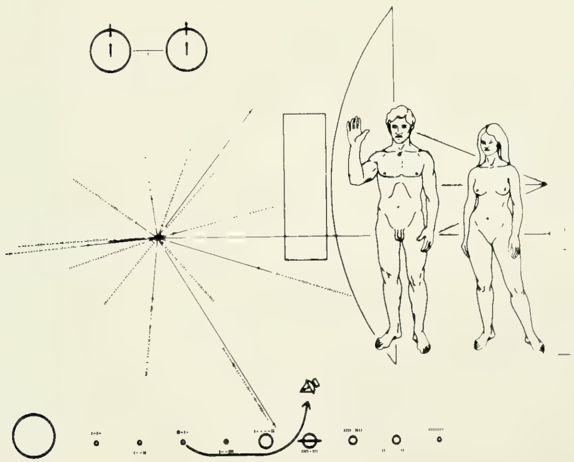
Now Drake is sending a similar message out to the stars. Because he is hitching a ride for his message on the Pioneer spacecraft, he can send it in picture form without first having to translate the desired picture into a number code that can be deciphered by a wholly alien intelligence. He is the first to admit that the chance of any response is very small, but he also makes it clear he feels the chance is greater than zero.

Drake, Sagan, and the national space agency have

already answered for themselves and for us, too, questions of whether we should call attention to ourselves, whether we should say anything to the universe at large. Until now we have listened, and we have sent into space a jumble of military and civilian radio waves that have announced the birth of a technical civilization. The aluminum plate on Pioneer is the first message we have consciously sent.

This is the third Sky Reporter column in five issues to discuss interstellar communication, which is probably a good deal more than you care to know about what I think on this subject. Now NATURAL HISTORY would like to hear from you. Do you think we should be listening more? What do you think we will hear first? Should we be calling attention to ourselves? If so, what should we be saying and how should we say it? What kind of a response do you envision?

NATURAL HISTORY will publish the most interesting and imaginative answers, then send them to people like Drake and Sagan for possible incorporation into the next message beamed to the cosmos. The magazine will also award modest but appropriate prizes for the letters we like best, making this the first Sky Reporter reader contest. So, if you have any thoughts on what we should—or should not—be saying to the rest of the galaxy, let us hear from you.



This message to unknown aliens starts with units of time and distance derived from minute changes in the energy levels of hydrogen atoms, upper left, the most common in the universe. In going from a state in which the spin of the electron and the spin of the proton are aligned, right atom, to one in which they are opposed, left atom, a hydrogen atom emits radiation at a wavelength of 21 centimeters every 1.4 billionth of a second. At extreme right, between the tote marks representing the height of the humans, appears the binary number 1 – – (which can also be written 100); this is 8 in the decimal system. Multiplication of that 8 by the 21 centimeters already established as a length unit gives a height of 168 centimeters, or about 5 feet, 6 inches. This number will also serve as a cross check for the aliens; if they have the message, they will have the spacecraft and can judge from that how big humans are. At left center is a polar projection of some object centered among 15 other objects. The binary numbers with each are too accurate to represent a distance; the only number that could be known with such accuracy would be the periods of pulsars. The solid line to each would then be its relative distance. Once the aliens identify the pulsars, they can pinpoint the origin of the spacecraft. And because pulsars slow down with time, they can also determine when Pioneer was launched. Finally, to help locate us even more accurately, the solar system is sketched along the bottom of the plate. Here the binary 1's must obviously represent some unit other than 21 centimeters; in this instance, they indicate a tenth of the diameter of Mercury's orbit. The binary number near each planet gives the multiple of this unit for that planet. Pioneer, having left the third planet and swung by the fifth (Jupiter), has its dish antenna still aimed back at the earth.

Celestial Events

by Thomas D. Nicholson

The Moon: Watch for the early crescent as it passes near Saturn, Venus, and Mars on the evenings of April 16 and 17. The moon is then in Taurus, but it will be in Cancer by April 20, when it goes through first-quarter, and in Libra when it becomes full on April 27. Entering the morning sky, it becomes the waning gibbous moon, passing Jupiter in Sagittarius on May 3 and reaching last-quarter on May 6. The waning crescent will be visible during morning twilight until the 10th. On the 12th the moon reaches perigee (when it is nearest earth) and becomes new eleven hours later. Expect perigee spring tides on the 12th, with greater than average high tides.

The Planets: Venus and Mars will be close to one another in the evening sky while they move from Taurus into Gemini. Mars is the lower and fainter, still dimming from its great brilliance of last summer. Venus is the higher and the brighter by far—brighter than anything but the moon in the nighttime sky. Both are visible until about three hours past sunset. Saturn, too, is an evening star in Taurus, visible to the right and below Mars and Venus during late April, but too close to the sun in May to be seen.

In the late evening, Jupiter rises in the southeast among the stars of Sagittarius, moves up to the south several hours past midnight, and remains in the dawn sky as a brilliant morning star in the southwest.

The Stars: In the evening sky, the very bright stars of winter are in the west, setting before midnight. Look for Orion over the western horizon, with the bright blue star Sirius in the southwest. The twin stars of Gemini, Castor and Pollux, are higher up in the northwest. The Big Dipper is above the North Star on these evenings, with the stars of Leo high in the south. Over in the east, Arcturus, in Boötes, and Spica, in Virgo, are rising.

Meteors: Maximum of the Lyrid meteor shower occurs on April 21. This is a weak shower (about 15 meteors per hour) of moderately bright meteors, some of which may be seen from the 20th to the 22nd. Best on the morning of the 21st, after midnight, with no moonlight after 2:00 A.M.

The waning crescent moon will brighten the morning sky from May 2 through 6, when meteors of the Eta Aquarid shower are expected. Maximum, with up to 20 bright meteors per hour, occurs on the 4th.

April 22: Venus and Mars are in conjunction.

April 24: Jupiter begins its retrograde (westward) motion.

April 28: Mercury is at greatest elongation (27°) from the sun in the morning sky, but poorly placed for observation.

April 30: The star Antares, near the moon this evening, is occulted over Europe and Africa.

May 3: The moon is in conjunction with Jupiter.

May 11: Venus reaches greatest brilliancy in the evening sky.

May 12: Perigee spring tides will accompany the new moon.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:20 P.M. on April 15; 9:20 P.M. on April 30; and 8:25 P.M. on May 15; but it can be used for about an hour before and after those times.


N
CASSIOPEIA
CEPHEUS
PERSEUS
CAMELOPARDALIS
Capella
DRACO
LITTLE DIPPER
Polaris
AURIGA
Mars
May 1
April 17
BIG DIPPER
URSA MAJOR
Castor
GEMINI
Betelgeuse
ORION
Pollux
BOOTES
W
April 20
Procyon
Arcturus
LEO
Denebola
Regulus
VIRGO
April 24
HYDRA
Alphard
Spica
CRATER
CORVUS
S

New Beaches from Old Bottles

Garbage, like pollution, is simply a resource that we are not exploiting

In the Pepsi generation, it is becoming increasingly difficult to dispose of waste glass. Nothing could be further from the truth than the widely held assumption that glass factories will happily accept an unlimited number of old bottles for the manufacture of new glass. There may, however, be another way to deal with waste glass, one that would solve two environmental problems at once.

Glass is made from sand, soda ash, and limestone. In the Middle Atlantic States these materials are abundant and inexpensive; their cost comes to about 0.85 cent per pound of glass produced. Subsequent production costs raise the price of bottles to 1 cent per pound, or $20 a ton, as a rough average for the industry. The makers of Coca Cola and other bottlers are now paying this price for used bottles, plus another $10 a ton for transportation from recycling centers to the nearest processing plant. This public service could not be offered if the bottlers had to pay the real costs of separating and sorting the glass as well; the separating is now done by the public.

Glass color, which is achieved by the addition of minor amounts of metallic oxides, adds to the difficulty. Cobalt is used to give a blue color, chromium or sulfur for yellow, slag and iron for brown and green, and manganese or nickel for purple. Separating glass carefully enough to maintain precise chemical quality control is difficult, and much of the colored glass received at recycling centers is currently being stockpiled because it cannot be used. Some work has gone into developing techniques for separating glass by color, such as optical scanning, which uses jets of compressed air to separate colored fragments from a stream of crushed glass, but most available processes are incapable of dealing with the large amounts of glass involved.

Making bottles from waste glass is not a new idea. One of the reasons for the general rarity of eighteenth-century American bottles is that this was a common practice in the early glass industry, as it is today. Householders saved used bottles and itinerant rubbish collectors made a good living collecting and returning them to be melted and reused.

Bottle-makers also recycle their own waste glass. As crushed glass, or cullet, it is returned to the furnace, where it may constitute from 10 to 30 percent of the total batch. The glass industry has set a goal of accepting 30 percent cullet in the manufacture of new bottles, but at present, one-third to all of the cullet is produced internally. Unless it is possible to raise this figure substantially, and no one has as yet suggested that it is, waste glass cannot be completely recycled even if the more immediate technical and economic problems can be overcome.

Many municipalities are now trying to reduce the volume of waste glass by drafting ordinances that would ban nonreturnable bottles, and similar bills are before a number of state legislatures. Such actions are poorly conceived and will not measurably improve the situation. They deal with only a small part of the problem.

Most glass is not made into bottles. Approximately 60 percent of the yearly production is in the form of flat, pressed, or blown products, used for everything from window glass to light bulbs, with containers making up the remainder. Only about half of these containers are beverage bottles; the rest are used for such things as aspirin and catsup. Thus, less than one-quarter of the glass produced annually would be covered by such legislation.

Anyone who has deliberately set out to find and use only returnable bottles has probably ended up weeping with frustration or cursing materialistic shopkeepers and bottling companies. But the public bears a large share of the responsibility for this phenomenon. In just seven years, 1964–71, the national average of round trips for returnable bottles has fallen from 17 to 14 for soft drink bottles and from 31 to 20 for beer bottles. Averages can tell a misleading story, however. The best estimate is that this number may drop to as few as two round trips in the cities. The average citizen is at least as reluctant as the retailer to get involved with returnable bottles.

The debate over returnable versus single-use bottles could easily become long and complicated. Returnable bottles must be thicker than those intended for single use; thus they require more glass. Before reuse they must be visually inspected for flaws and then ster-

by Michael D. Piburn

ilized. This process could conceivably produce unacceptable levels of effluent in the form of caustic solutions or detergents. The important question is whether, when the energy consumptions are compared, the process of collecting, returning, and refilling bottles is more efficient than that of throwing them away and making new ones. This question has not yet been answered.

The relative merits of glass versus plastic or metal as a food-packaging material are also the topic of considerable debate, but glass remains an attractive material for this purpose. It is cheaper than either aluminum or plastics, which cost nearly $600 per ton to produce, and it can be produced and disposed of with minimal environmental damage. There are more important uses for plastics, which are made from our dwindling petroleum reserves, and the production of aluminum from bauxite uses large amounts of energy and is often highly polluting.

If the rapidly rising use of glass containers continues, the problem of waste glass disposal will intensify with time. One of the most interesting proposed uses for large amounts of glass is the manufacture of "glasphalt," a road-surfacing material being developed at the University of Missouri at Rolla. In the New York metropolitan area, however, the amount of available glass exceeds the demand for aggregate used in road construction, although the situation is reversed in many other parts of the country. In any case, the prospect of building even more roads because of pressure to consume ever increasing amounts of waste glass is a bit frightening.

Building materials, including bricks and insulation, are also possible products of a waste glass industry. Whether reclaimed glass could compete with primary raw materials for such purposes is still questionable.

A reasonable assessment of cost and environmental damage suggests that glass should be preferred over other materials for containers, and that waste glass should be dumped in the cheapest and least damaging way. Unfortunately, our previous enthusiasm for dumping puts us in an embarrassing position. There isn't really any place left to dispose of large amounts of material.

The principal method of handling solid waste is landfill without burning. Of approximately 12,000 land disposal sites in this country, the American Chemical Society estimates that only 6 percent are adequate, sanitary landfills. Assuming that local health regulations, which require compacting refuse and covering it with inert material, can be enforced, and that problems of groundwater contamination and the generation of gases from decaying material can be overcome, this will probably remain the most important method of disposal in many parts of the country for some time to come.

Most solid waste disposal in the New York–New Jersey area has been accomplished by filling wetlands. Although this critical environment is protected by law, it is not adequately mapped and enforcement is virtually impossible. New Jersey's Department of Environmental Protection estimates that between 1950 and 1970 the state lost one acre of wetlands per hour. Even this resource will soon be exhausted, and some experts believe that in the New York area the crisis for disposal space will come as soon as 1975.

Buckminster Fuller has remarked that pollution is a resource that we are not exploiting. In some senses this is also true of garbage, which can be thought of as a low-grade and highly dispersed ore deposit. Paper or paper products make up almost three-quarters of all municipal refuse, and this alone gives it a value of nearly $3 per ton. Garbage also contains about 8 percent metal, which adds to its value. Many mines extract ores with less value, but the high cost of collecting garbage makes it unlikely that a profit can ever be realized. Reclamation of such materials, however, would help to defray the total cost of handling municipal refuse as well as meeting most of the goals of the recycling movement.

In most large metropolitan areas it will become necessary to adopt some major solid-waste-processing system of this sort. If incineration is involved, the residue will be a deposit of metals and glass that must be crushed for separation. One of the easiest products to manufacture at this stage is a synthetic sand with controlled sorting and size characteristics. By a strange set of coincidences, sand is exactly the material that is badly needed in the immedi-

ate vicinity of many urban centers. Shore communities spend millions of dollars annually to replace sand swept away by ocean currents. They also spend money to dump waste glass that could make beautiful sand.

New Jersey is a case in point. Except for the coast between Bay Head and Monmouth Beach, the shoreline of New Jersey consists of a series of sand islands separated from the mainland by shallow marshes and bays. These barrier islands developed after the last continental glaciation as a result of rising sea levels and now continue to exist by the grace of a very delicate equilibrium.

Longshore currents are constantly moving sand north and south from a nodal point near Manasquan. Littoral drift, the rate at which sand is moved, ranges between 200,000 and 500,000 cubic yards per year. Sand is fed into this system by the erosion of Cretaceous and Tertiary sediments, which are exposed in the vicinity of the node, as well as being carried to the sea by rivers. The eroded material then moves north toward Sandy Hook and south to Cape May, ultimately disappearing into submarine canyons at the mouths of the Hudson and Delaware rivers. Sand is lost constantly from this system, principally by erosion from the beaches and by transport offshore into deeper water. In the vicinity of Sandy Hook the system experiences a net annual erosional loss of one to two cubic yards of sand per linear foot of shoreline.

The islands of New Jersey are heavily settled, and summer populations in the north are dense enough for the area to be classified as urban. The desire to protect public property in this delicate setting has led to a number of elaborate and expensive programs to halt beach erosion.

Attempts to stabilize eroding beaches have taken two forms. The earlier and less effective method established stone groins at right angles to the direction of longshore currents to trap sand and diminish the amount of erosion. Unfortunately, deposition of sand upcurrent from the obstruction is frequently offset by accelerated erosion downcurrent. It is now commonly accepted that maintenance of beaches can best be accomplished by supplementing the system's sand supply to overcome erosional losses.

Sand for beach nourishment has most often been supplied by dredging the bays behind barrier islands and pumping the sand across the island onto the beach. The environmental consequences of such a practice are predictably disastrous because these bays and estuarine areas are important breeding grounds for a wide variety of terrestrial and marine organisms, such as the bay clam, horseshoe crab, flounder, and a wide variety of migratory waterfowl. The process also doesn't work too well. Between May and July of 1952, 2,550,000 cubic yards of sand were placed on the beaches of Ocean City by this method, at an estimated cost of more than $1.5 million. This beach fill eroded at the rate of nearly one million cubic yards per year until its complete disappearance in 1955.

The use of artificial sand in place of natural material would not only reduce the stress on bays and estuaries but might also lead to greater beach stability and a consequent reduction in the amount of material needed to replace erosional losses. Most available sand, like the sand that disappeared so quickly from the Ocean City beaches, has too small an average diameter for maximum beach stability. Coarse sand is more desirable, and artificial sand could be prepared in any needed size range. It might also be possible to experiment with a range in size of particles and grain shape to maximize beach stability.

Comparisons of the quantity of glass available with the amount of sand needed are favorable. The Army Corps of Engineers calculates that after an initial, massive beach fill, effective stabilization of beaches along the entire 130 miles of New Jersey coast could be accomplished by annual replenishment of one to two million tons of sand. In 1967, 320,000 tons of waste glass were generated by New York City alone. It seems reasonable to assume that New York and Philadelphia, together with the major metropolitan areas that surround each, could provide more than enough glass for this purpose.

Glass fragments would be quickly rounded in the surf, so that they would present no danger to people on the beach. Since they would also be frosted to a uniform white color, they would be indistinguishable from natural sand. If for some reason the presence of sharp particles was not acceptable for even brief periods of time, crushed glass could be abraded as part of the initial processing before it was placed on the beach.

It is difficult to assess the economic aspects of such a proposal. Transportation of sand from processing plants to beaches would probably cost in the vicinity of $10 per ton. Since it now costs $5 a ton to dispose of the waste glass, the net cost of this artificial sand delivered at the beach would be $5 a ton.

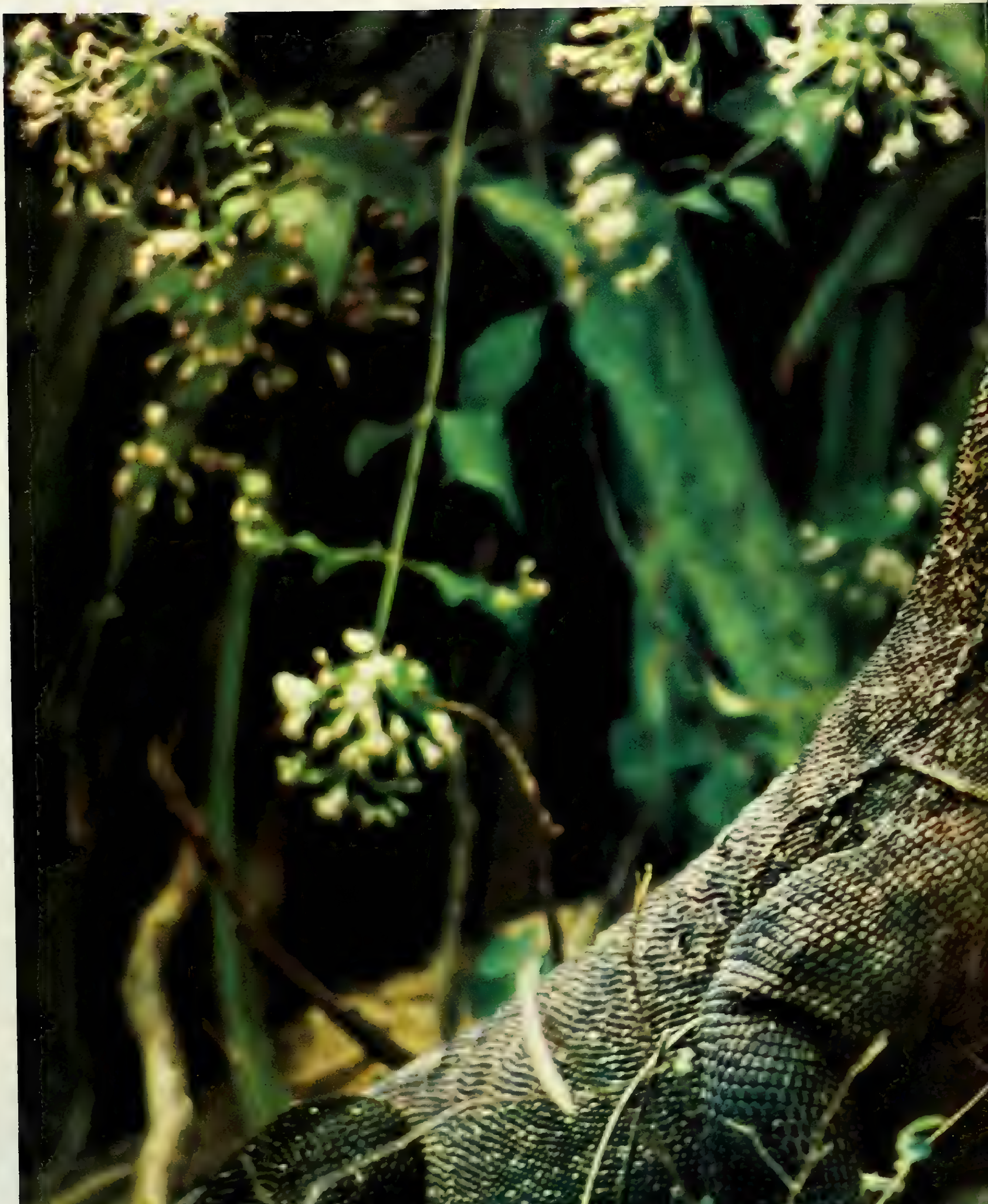
Current methods of beach replenishment cost $2 to $3 per linear foot of beach. It takes one to two tons of sand to do this, so the artificial sand would raise the cost to $5 to $10 per foot of beach. This cost could be reduced if some of the earnings from the sale of other reclaimed materials were applied to the cost of transporting the processed sand. These figures are only crude estimates, but it does appear that this proposal could become economically feasible, even if the value of the estuaries thus saved is not taken into account.

In any case, we have long since passed the point where there is any alternative to waste-recycling solutions such as the one I have outlined. Land disposal sites adjacent to urban centers are nearly exhausted. Even if cities like New York and Philadelphia start reclaiming solid waste, they will still have to dispose of recycled material, such as glass, for which the supply will exceed the demand. The only place to dump these unwanted materials will be the oceans.

If we can ease this problem and, in the process, alleviate the destruction of irreplaceable inshore breeding grounds, we will have achieved more than is usually possible when looking for the best way out of a bad situation. ■


Ruffins

Komodo



Dragons by Walter Auffenberg

Through the rain forests and savannas of six Indonesian islands, the largest lizards in the world track down their prey, dead or alive

The wild hog ambled along the forest trail, head down, feasting upon fallen tamarind fruit that lined both sides of the path. Intent upon the fruit, the animal failed to notice that it was being stalked by a huge lizard, fully seven feet long, intent upon its own meal—a succulent pig. When the distance between predator and prey closed to about 3½ feet, the lizard lunged and, with its formidable teeth, grasped the hog's right thigh. Squealing, the pig tried to turn around to bite the powerful reptile, but the lizard hung on, then jerked back hard and brought the pig down on its side. Releasing the leg, the lizard quickly bit into the soft flesh of the belly; before the pig stopped moving, the intestines were nearly consumed.

Witnessing such an event would probably be a chilling experience for most onlookers, for while more people now recognize, and some even understand, the naturalness of a lion or leopard making a kill, the sight of a lizard bringing down a large mammal would, I think, elicit more than the usual mixed feelings of revulsion and excitement generated by other predators capturing their prey. This reaction might have some roots in the dragon mystique prevalent in mythology, nurtured by tales of Saint George and his fire-breathing opponent. The Komodo monitor, however, is not a legend. This largest of all lizards,

On Komodo Island, concentrations of monitors vary considerably, ranging from only a few individuals in denuded terrain, above, to 25 per square mile in optimal savanna grassland habitat.

known locally as the ora, is very real, with some specimens attaining a length of ten feet and a weight of between 150 and 200 pounds. Oras are relatively little-known because few zoos have exhibited them and because of the remoteness of their habitat in the Lesser Sunda Islands of Indonesia.

There, on the islands of Komodo, Flores, Rintja, Padar, Owadi Sami, and Gili Moto, the huge lizard *Varanus komodoensis* roams the monsoon forest and savanna in search of prey or carrion. A highly opportunistic carnivore, the lizard begins life with a slender body, thin tail, and a length of 16 to 20 inches. Growing rapidly, it attains a length of six feet in its first few years of life. The next changes in its development are more remarkable, as a massive, powerful body, with a wide, truncated head and a relatively short, thick tail, takes form. Eventually, in individuals reaching full maturity, lengths of eight to ten feet and top weights of 200 pounds are attained—impressive dimensions for a reptile.

Their teeth, looking more like those of a shark than a lizard, convey the impression of an animal capable of making short shrift of unwary prey or available carrion. Compressed from side to side, they form a slightly recurved, triangular blade somewhat like the cutting blades of a mowing bar. The keen posterior edge of each tooth is finely serrated, like that of a steak knife. Complementing this dental arsenal, sharp, talonlike claws at the end of strong, stubby toes help to tear apart larger sections of flesh.

The striking and highly varied feeding habits of these lizards, which our research team studied for more than a year, provided an excellent basis for arriving at some conclusions about the biology and the ecological role played by these well-adapted predators and scavengers and dispelled some previously held beliefs.

The published reports of almost all previous expeditions that studied Komodo monitors emphasized the idea that *Varanus komodoensis* is a scavenger because it regularly fed on rotten carcasses that were used as bait. The regularity and relative speed with which they come to rotten flesh had even suggested to some researchers that large specimens are entirely scavengers. Naturally, one wonders how a relatively small island like Komodo could supply the large numbers of dead animals that would be needed to support the monitors.

Our research team found that monitors remain in trees most of their first year, feeding on small animals such as geckos. Not until they are about three feet long, or approximately one year old, do they start

scavenging. In 351 instances of monitors scavenging rotten bait during our year on Komodo, only eight involved lizards less than three feet in total length, and hatchling-sized monitors were never seen at a carcass. The smallest specimens of *Varanus komodoensis* are, in fact, pure predators.

As for larger-sized specimens, whether they are scavengers or predators is a matter of opportunity. Contrary to the recent suggestions of some authors, who assumed that monitors would be incapable of capturing sizable prey when carrion is not abundant, oras are resourceful and successful predators. It is ridiculous to accept the fact that a 40-pound trained hunting hound, for example, can bring down a large deer while at the same time denying that possibility to a 150-pound reptile.

As predators, Komodo monitors can successfully attack virtually every animal—from insects to water buffaloes—found within their habitat. Grasshoppers, rats, birds, goats, hogs, and deer are the most commonly preyed upon, with the incidence of predation on each a function of the size of the lizard. Insects make up the bulk of the diet of very small monitors; rodents and birds the preponderance of food for medium-sized individuals; and deer the favored food of the larger specimens. As physical maturity is attained, their ability to bring down animals the size of water buffaloes increases.

Tethered domestic goats on the islands are often attacked under their owners' stilted houses, even though they are surrounded by barking dogs and shouting villagers. They are also taken in the pasture areas around the villages. In the savannas of western Flores goats cannot be tied and left unattended for long without danger of attack.

Most of the smaller islets near Komodo and Flores are periodically stocked with goats, which forage and breed until harvested by the owner. The situation on one of these islets, Nusu Mbarapu, is particularly interesting: when its goat population is fairly high and when, for some reason, prey populations on nearby Komodo are low, large monitors will swim 1,300 feet of swift tidal currents to the islet and live there, eating goats until the population is reduced to a level where the chance of further success is very low.

Monitors kill goats by grasping them by the neck, away from the thrashing hooves. Goats are easily held down, dragged, or even lifted up and carried, and the monitors shake them violently from side to side and up and down—probably either to increase the severity of the wounds or to break the neck. Death comes quickly, usually in 2½ to 4 minutes.

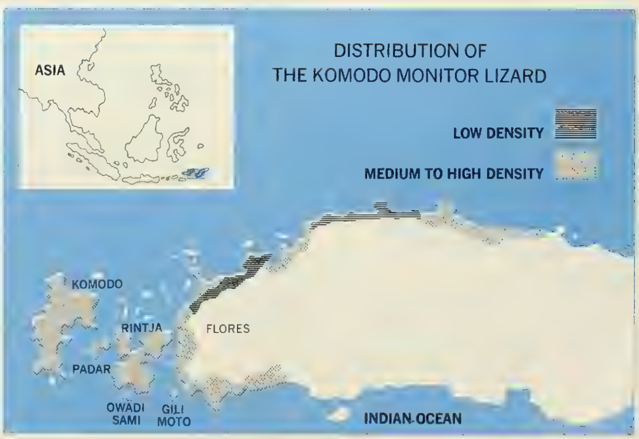
Wild hogs are another common component of the lizard's diet. Usually ambushed along the game trails, the pigs are grasped by the throat, head, or thigh and jerked violently from side to side. They are later bitten in the belly so that the intestines fall out, after which death is rapid.

But the chief prey of the larger monitors are the rusa deer of the area. The stags of this species are considerably larger than the does, sometimes attaining a weight of 440 pounds; and, like most deer, their sight is only moderate. Smell and hearing are very acute, however, and communication between individuals is accomplished by several types of scent glands, stamping of feet, and the alarm calls and vocal challenges of males.

Deer feed mainly at night on a variety of grasses, leaves, and fruits. With the approach of dawn, they choose a resting place, usually in high grass, which serves as cover, on a flat-topped ridge above the forested valleys. The deer lie there, awake and ruminating, until late morning when, probably because of the increasingly hot temperature on the open slopes, they begin moving down into the thicker vegetation on the valley floors. This is when the monitors do most of their serious hunting, lying in wait along the game trails leading to the valley. Choosing one trail from the several on any slope, a monitor will lie in wait during the late morning hours, expecting a small troop of deer to move past. Of course, the possibility of a successful hunt along any one trail is slight, but the level of success must be sufficiently high to elicit this behavioral pattern almost every morning.

Having reached the deeper valley forests, the deer move rapidly to their daytime sleeping places, usually under some evergreen shrubs. The lizards that were unsuccessful along the trails in the morning follow slowly until, having reached the thickets, they begin an afternoon hunt in which they attempt to capture sleeping deer.

For a monitor to catch a deer during this time, it must locate a herd out of the large number of potential sleeping sites within its activity range. Since few pellets are dropped by the deer during this period, this scent is not a major factor



in the successful location of sleeping deer. There is evidence from some ungulate studies that secretions from the metatarsal glands are important in marking sleeping and resting sites. If this is also true of rusa deer, it is possible that the monitors find sleeping individuals by this means. Our data from Komodo suggest, however, that the hunting monitor depends on past experience and knowledge of the area, checking—in a uniform and steady manner—all the potential resting places along, or close to, its particular hunting circuit during that afternoon. Deer on Komodo often frequent the same spot for several successive days, and it is possible that they move to another only after having been attacked by a hunting monitor or a pack of feral dogs.

Two other large herbivores, the feral horse and the water buffalo, are also preyed upon by this giant lizard. Standing four feet high at the shoulder, and weighing an average of 550 pounds fully grown, the usually alert feral horses are vulnerable when asleep, when moving along game trails, and most importantly, when the mares are giving birth. Foals weighing between 45 and 55 pounds are born throughout most of the year, and a monitor will wait for the foal to drop from beneath a hunched and straining mare, dodging whatever kicks the mare can manage to aim in its direction. The exhausted mare is in no condition to protect her offspring after the birth, and the lizard finds it easy to move in and grab the helpless foal.

Water buffaloes—huge, blocky bovines weighing as much as 1,300 pounds—would be formidable and dangerous prey for many would-be predators. Komodo monitors, however, can bring down the largest specimens, whether tethered or free. Obviously, these animals are too large, powerful, and fierce to be successfully subdued by any straightforward attack mounted by a lizard. Instead, the monitors use a technique of creeping close enough to the much larger buffaloes and biting a hind leg with their sharp teeth. The lizard's tenacity, coupled with the buffalo's struggles to free itself from the viselike hold, often results in a severed Achilles tendon, which forces the buffalo to drop to the ground. The much larger animal, now incapable of defense, is then rapidly dispatched by evisceration. Over a period of several days, an increasing number of monitors will slowly gather to feed at the rotting carcass of a large buffalo.

Analysis of buffalo remains found in monitor droppings, as well as statements by villagers, indicate that calves are more commonly attacked than adults. This would be expected because of the relative difficulty of capturing mature individuals. The opportunistic nature of the Komodo monitor's feeding habits is further revealed by the fact that most buffaloes eaten are carcasses of animals that have died of other causes. So, whether death occurs through the monitor's own efforts or for other reasons, buffalo meat becomes a staple of its diet.

Cannibalism is also a factor in the diet of large monitors. In one area of Komodo, remains of smaller individuals were contained in 8.8 percent of all droppings of large specimens. As in other carnivores, cannibalism is most common during periods of high population density, but the ecological separation of size groups in *Varanus komodoensis* tends to keep densities uniform over fairly large areas. Large monitors will, however, attack and eat any smaller individuals they can manage to corner.

Occasionally, humans are also the objects of this lizard's unpro-

Mating is a direct affair, with little preliminary display. Sexually mature individuals meet and copulate at congregations around kills and carrion.

voked attack. In several instances, people have been bitten in the shoulder and neck as they slept on the ground during the daytime. Others were attacked from behind while working in the bush. One of these died soon after receiving such wounds. At least one person is also known to have died from massive sepsis, a toxic condition resulting from bacterial action in an infection, four days after being severely bitten in the biceps. Other, less severe cases of infection following bites are also known.

Of the approximately 600 monitors encountered by expedition members, 400 at feeding sites and 200 in the bush, very few showed any interest in us. Most fled when approached too closely, some entered our tents and blinds and drove us out, and a few threatened us and refused to budge when we encountered them in the forest. Some were aggressive without provocation, attacking and even tearing part of our clothing into shreds. Such behavior was only exhibited by certain monitors, however; the vast majority were exceedingly shy of our presence.

The ability to produce a severe, septic wound, presumably a staphylococcal infection, is of extreme importance to the Komodo monitor, far more so than for other predators. A wound inflicted on a deer or antelope by the unsuccessful attack of a large predator may become septic, making the prey more susceptible to a second attack at a later time, but most likely by some other predator. And, if the prey dies of the infection, it serves as food for specialized scavengers. With the Komodo monitor the situation is quite different because, with the exception of recently arrived feral dogs, it is the only large predator or scavenger in its habitat. A deer, weakened or dead as the result of a septic wound produced by one monitor, becomes either live or dead prey for others, so that from the standpoint of the monitor population, the initially unsuccessful attack is eventually successful.

Like most carrion seekers, the Komodo monitor scavenges rotting meat by scent. Monitors have an extremely sensitive olfactory mechanism, but for the system to work over areas of several square miles, the carcass must produce a powerful odor. During the first day after death, an animal's volatile oils of decomposition are not produced in sufficient amounts to attract any but the closest lizards. After 48 hours the decomposing process is sufficiently accelerated to produce a powerful scent, and lizards will move toward the carcass from over a large area. The distance over which a carcass will attract the reptile depends on the direction, steadiness, and strength of the wind, as well as the amount of scent produced. Everything else being equal, the scent of a larger carcass is stronger and will be sustained for a longer period of time, attracting more individuals to it. The greatest proved distance from which we attracted lizards to bait was approximately five miles. I am sure that under most circumstances this distance would not be greatly exceeded because a single deer carcass produces only a finite quantity of volatile decomposition products.

Because there are so few species with which the Komodo monitor competes for a carcass, it is probably forced to share less carrion

with other organisms in its range than any other large scavenger in the world. These competitors include a few birds, hogs, several species of beetles, flies, and within historic time, feral dogs. Except for the dogs, none of these are important competitors.

Next to the monitors, feral dogs eat the largest number of both fresh kills and carrion on Komodo and Flores. Unlike hogs, these animals are much more active and aggressive in their attempts to take carrion from the monitors or to drive them away. Normally the dogs sit several yards away from the closest feeding lizards. From time to time they will harass them by rushing in, barking, and snapping. The larger lizards usually pay little attention, although they will attack and kill the dogs if an opportunity presents itself. Smaller lizards, however, are frequently chased from a carcass by the harassments.

When carrion is left overnight, the dogs are likely to eat most or all of it. As with the hogs, this is the most important period for direct competition with the lizards for available carrion.

Scarabid beetles also compete for the flesh of dead animals. One night we hung a freshly killed goat near our base camp; later we were attracted to the bait by what sounded like thousands of small squeaks. When I played my flashlight over the carcass I found that most of it was covered by these beetles. By the time they left next morning, they had consumed approximately eleven pounds of flesh. Hilmi Oesman, of the Surabaya Zoo in Indonesia, reports that on one of his former expeditions to Komodo, hordes of beetles completely consumed the flesh of a medium-sized goat in one night.

Although monitors compete among themselves for carcasses when several individuals are attracted to a dead animal, these small, casual aggregations are not really social. They last no longer than one or two days, or until the prey is completely eaten, and involve little true coordinated behavior of any sort. During these periods, however, it is important that two opposing factors are operative: one is cooperation; the other, disoperation. The latter is best illustrated by the fact that the largest individual at the carrion usually takes the best feeding position and eats the best parts of the food. This individual determines in which direction the carcass will be moved, when it will be moved, and under what conditions. This disoperative factor is obviously dependent on rank order, based largely on size, although there is some evidence that prior experience may also be important. Such hierarchy determines the feeding sequence and the amount eaten by the smaller individuals as well. In general, the hierarchical system is established and reinforced in these feeding aggregations.

Cooperation is the other major factor. On several occasions very large lizards attempted to swallow particularly bulky parts of the carcass, such as the entire head, but were unable to do so because it was still connected to the remaining portions of the body by ligaments and flesh. The larger individuals would frequently swallow as much as they could, and then pull steadily backward. At these times, smaller individuals would move toward the carcass from either side and start to tear meat from that part of the carcass immediately in front of the larger specimen's jaws. After a short time these smaller individuals had often removed all the meat in that area and cut many of the tendons holding the carcass together at that joint. It was then easily separated by the larger lizard, which had continued to pull at the piece. Thus the larger oras obtained their share of the pieces that were more difficult to separate from the carcass, and at the same time it was possible for the smaller specimens to obtain more meat than would ordinarily be the case. I am sure that in these instances the smaller oras approached the larger ones more closely than usual only because they recognized that when the larger specimen had its mouth full it could not attack them.

The size of the pieces swallowed and the amount eaten is sometimes astonishing. A previous expedition saw a monitor swallow the entire hindquarters of a deer in one gulp—hooves, legs, vertebrae and all. I have often seen them do the same with full-grown goats. One 8½-foot ora was seen swallowing an entire month-old fawn, without eviscerating it. We also saw a monitor weighing about 110 pounds eat absolutely all of a 90-pound wild hog in seventeen minutes. I have seen very hungry lizards eat the slipped horn sheaths of rotten goats when all the flesh had already been eaten by other lizards. Hair is usually spit out when it slips from the rotten carcass, but when attached to large pieces of flesh it is often eaten. Lizards will occasionally use their claws to scratch at the carcass hide, pulling the slipping hair off before eating a rotting carcass. Bones, even when cleaned of flesh, are usually swallowed if not too dry. Hunger will drive monitors to eat food that is low in the scale of preference or unfavorably situated. Disturbance by man, interference by village dogs or other monitors, or the location of carcasses at an unsuitable site often prevents feeding even when the kind of food is highly preferred. Whether a carcass is eaten depends upon the balance among these factors. Carcasses of deer, hogs, and goats are the foods most eagerly eaten by large specimens. It is doubtful that a dead deer or boar could lie for more than three days in a suitable area without being consumed.

The removal of prey animals by monitors is highly important in maintaining ecological stability in what is a delicate wilderness environment. Long-lasting range damage caused by an overpopulation of prey species is reduced by the dampening effects of monitor predation. Severe fluctuations in prey populations are held in check until such time as the actual limiting forces of food availability and disease become operative.

Also, the selective predation pressure of the monitors removes primarily the young and old animals, which, due to inexperience or debilitated physical condition, are the most vulnerable. Our data make it clear that prime deer and buffalo are avoided, and wild boar killed only slightly more indiscriminately. In the Komodo study area, where

deer populations are dense, monitors killed a large proportion of individuals younger than one year and older than seven years.

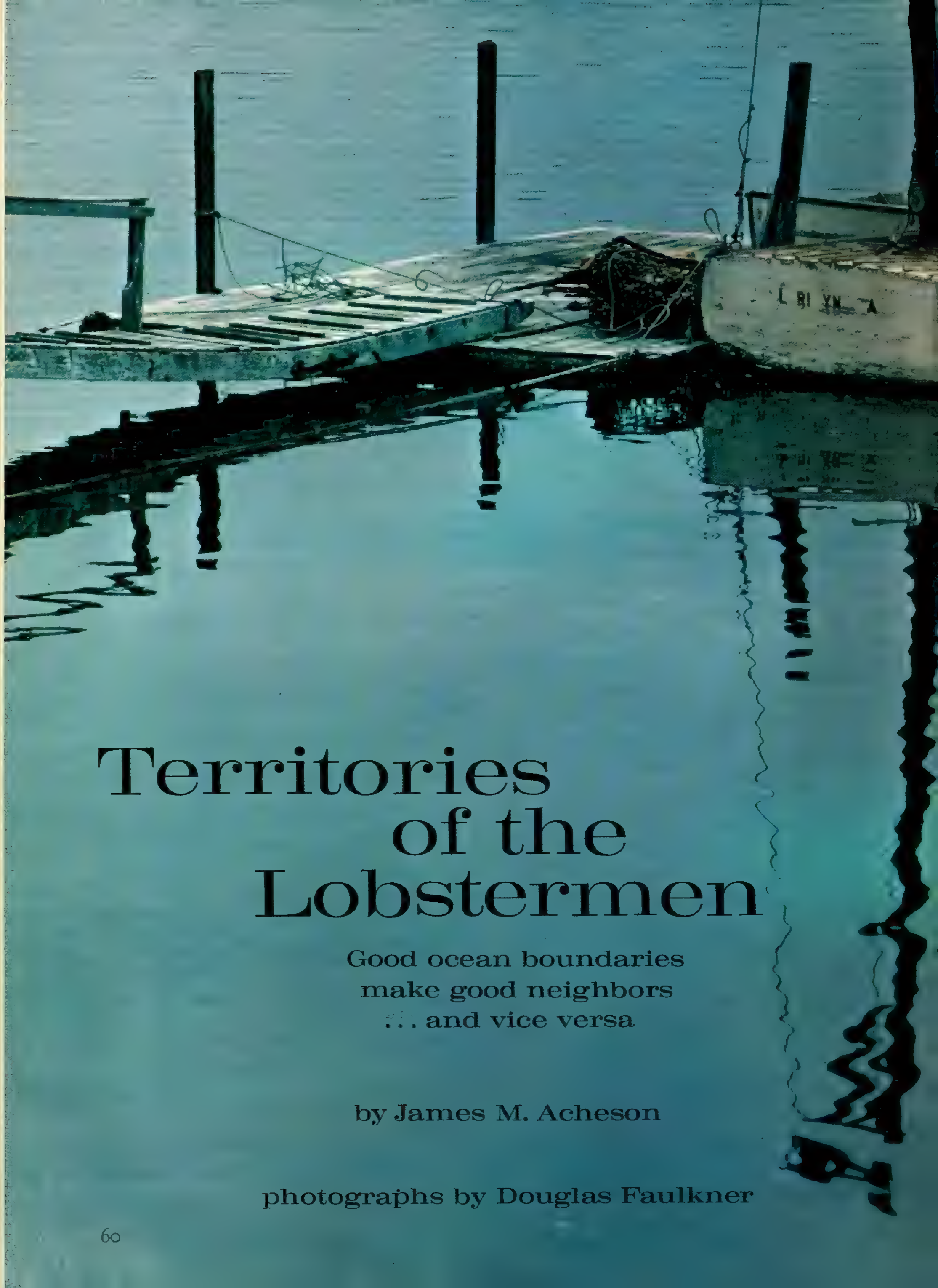
An important objective of our study was to determine the status of the Komodo monitor in terms of its survival as a viable species. It has long been feared that these lizards were on the verge of extinction. What we found was that both the numbers of monitors and the area inhabited by them are larger than previously assumed, and that extinction is not imminent. But the geographic range is still small, and history has shown that animals so situated are highly vulnerable if their habitat is "opened up" to various types of development.

The area involved here is potentially rich in minerals and oil, and so it can be reasonably assumed that it won't be long before schemes are proposed to exploit these natural resources. Also, as in many other parts of the underdeveloped world, the government views tourism as an important future industry, and ironically, it is thought that tourists can be persuaded to visit the Lesser Sunda Islands because of the dramatic presence of the Komodo monitor. But the impact of the techniques used to extract oil and minerals, and the influx of hordes of people upon a restricted environment can be disastrous to the wildlife living within it, as countless examples in other parts of the world have demonstrated.

Another important factor in the continued survival of the species is that, although there now appear to be as many Komodo monitors as there ever have been, their total population numbers only about 5,000 animals over their entire range, only about one-third of which are mature individuals. Of these 1,500 mature adults, only about 350 are breeding females.

Yet, to those who would recommend that all of the monitor's range be considered inviolate, I submit that such a proposal is completely unrealistic in Asia at the present time. The pressure to utilize "unused" land in such countries as Indonesia will become increasingly intense in the near future. Human overpopulation in the Lesser Sundas, the monitors and their prey species, and the environment must all somehow be manipulated intelligently if a compromise is to be obtained between an important wild animal resource and the demands for higher standards of living. Hopefully, our work and other future studies will contribute the knowledge necessary to create effective planning programs that will satisfy the needs of both man and animal.

Scent given off by a nearby carcass attracted these medium-sized monitors from a wide area. Most social behavior, including the establishment of hierarchies, occurs when the lizards come together at feeding sites.



Territories of the Lobstermen

Good ocean boundaries
make good neighbors
. . . and vice versa

by James M. Acheson

photographs by Douglas Faulkner

According to the law of the State of Maine, anyone with the proper license can fish for lobsters in any waters of the state. Yet every year, fledgling lobster fishermen set out strings of traps or summer residents put out a few traps "for fun" only to find their traps opened, damaged, or gone when they return. They soon realize that the local lobstermen consider them interlopers in private fishing territories.

The local legal system, which rules lobstering off the rocky coast, sometimes runs counter to the laws of the state and nation. It may be enforced with surreptitious violence, which can escalate into "lobster wars" and even homicide.

But the lobstermen are not outlaws, obeying their own code and ignoring state laws. For example, they almost universally obey the conservation laws concerning licensing and the taking of either undersized "short lobsters" or breeding females. But these formal laws are relatively few in comparison with the numerous traditional norms by which lobstermen govern themselves.

The rules for lobster fishing territories are especially critical because they control access to the lobsters and because they have important ecological implications at a time when some parts of the marine resource are being overexploited.

Growing up in an inland area of Maine, I was for a long time vaguely aware that territoriality existed among lobstermen. Only recently, however, did I find evidence of these territorial rules and investigate them systematically.

About five years ago, I helped a friend, a recently retired New Yorker, who was attempting "to break into the lobster game," as he phrased it. This was going to be a part-time activity for him, a way of

A Maine coast dweller marks the boundary of his land. On the ocean, boundaries may be less obvious, but feelings about them are as strong.

supplementing his Navy pension. He only laughed at warnings about any problems, stubbornly insisting that the Atlantic Ocean was part of the public domain and that all one needed was a state license to go lobster fishing.

Accordingly, he bought an old boat and 190 new traps and proceeded to go lobstering. I was with him the first day he pulled his traps. In the first row of traps we pulled, one was missing, possibly destroyed by accident, we decided. But at the second string, the trend became clear: ten traps out of seventeen—at least $150 worth of gear—were missing. The destruction was deliberate, as we found the cut-off buoys floating over a two-mile area. For the rest of the morning it took little to goad my friend to the heights of eloquence concerning the ancestry of lobstermen, their inborn criminal tendencies, and their sneaky and arrogant ways. He was incredulous that lobstermen would "survey off the Atlantic Ocean," as he put it, and have the gall to enforce those boundaries.

Maine lobstering takes place in a spectacular natural setting. Eons ago, the coast of Maine sank. What were once valleys and river basins are now long, indented bays that create a highly irregular coastline. It is only 250 air miles from Eastport, Maine, on the Canadian border to Kittery, across from Portsmouth, New Hampshire, but stretched out, the coastline is some 2,500 miles long. There are a great number of deep, well-protected harbors. The rocky headlands—covered with dark, stunted spruce—are continually pounded and showered with foam by long, rolling waves coming in off the open ocean. Up the bays and rivers are mile after mile of small islands and coves.

The little coastal communities nestle in small, sheltered harbors filled with boats. The shores are covered with a jumble of weatherbeaten docks piled with fishing and lobstering equipment. Clustered behind the waterfront, the people live in plain clapboard or shingled houses from which they can easily watch boats, equipment, and the weather. Behind the houses are evergreen forests.

The cold water off Maine's coast provides an ideal habitat for halibut, shrimp, cod, haddock, sardine, and lobster, but a poor place for swimming. The statement that "only tourists go in the water" is more than a joke. Many lobstermen cannot swim, feeling with some justification that swimming offers them little insurance in such waters. The thick fog, present as much as 180 days a year, adds to the danger. Even with modern safety devices,

lobstering is not a safe occupation. Every coastal community has its list of men lost at sea.

At any time of year, lobstering is difficult work. In the summer, men usually haul pots, or traps, every day, starting before daybreak so that they can complete as much of the task as possible in the calm morning hours. In winter, bad weather makes it impossible to go out more than one or two days a week. On a sunny, calm day, winter lobstering can be almost pleasant. But when the temperature hovers around zero and one is wet with spray, eight or ten hours on a bouncing lobster boat can be miserable. At this time of year, one does not have even the compensation of a large catch. Many men prefer to pull all their traps onshore in midwinter and to spend their time working on equipment.

Lobsters are caught in wooden traps about three feet long, made of spruce slats, or lars, over oak frames. The style of trap has remained essentially the same for at least 100 years. The lars are spaced about an inch and a half apart, allowing the undersized lobsters to escape while trapping the legal-sized ones. One end of the trap is left open and rigged with a funnel-shaped nylon net, or head, so that a lobster can easily climb in, but not out of, the narrow opening. Traps are baited with fish remnants, obtained now from fish-processing plants in nearby cities. A "warp" line attaches each trap to a floating buoy, made either of wood or, more commonly, of styrofoam. Buoys are painted a distinctive combination of colors to allow each man to identify his traps at a distance, and the individual designs are registered with the state.

In shallow water, normally one trap is attached to a buoy, while in deep water it is common to attach two to one warp line; this is called "fishing doubles." In the Casco Bay region, the standard procedure, known as "trawl fishing," is to attach several traps to a single line. In all cases, traps are set in rows, or strings, 100 to 300 feet from each other, close enough so that a lobsterman can see from one buoy to the next, even on a foggy day.

The amount of equipment used by individual lobstermen varies greatly. A high school boy, just starting out, might have as few as 20 traps, which he tends with an outboard-powered skiff. An experienced lobsterman, especially in the area where trawl fishing is common, might have more than 1,000 traps, a 40-foot boat costing more than $20,000, and a two-man crew. The average lobster fisherman tends 400 to 600 traps by himself, using a 30-foot boat costing about $15,000.

Lobsters are marketed in the lobsterman's home harbor through a dealer with whom he has close economic ties. The lobsterman will sell his entire catch to his dealer, and purchase gas and supplies from him. In return, the dealer will allow the lobsterman to use his dock, provide him with bait at close to cost,

Maynard Winchenbach spends many hours repairing and rigging lobster pots. The buoys, top, are painted in his registered pattern.

At low tide in the winter, lobster boats drift at their moorings in New Harbor. Many pots are stored on the docks in this slow season.

and extend credit for rope and other gear.

To go lobstering, one must be accepted by the men already fishing out of a harbor. These groups of men have no special name, but are referred to by the name of their harbor: the "Friendship gang" or the "Monhegan boys" or the "men from Boothbay." Once a man gains admission to one of these harbor gangs, he usually can fish only in its traditional area.

In cases where townships have two or sometimes three harbors within their boundaries, each harbor has its own gang with its own traditional territory. The men from the village of New Harbor, for example, go lobstering out of Pemaquid Harbor and New Harbor. While they live side by side in one community, they fish in separate traditional areas.

Anyone just starting out as a lobsterman will experience some hostility. Many resign themselves to a long period of harassment before they are accepted; many never make it. However, a man will have the best chance of establishing himself if his family are long-time residents of the town, if his father's family are lobstermen, and if he is well liked in the community. Such a man almost inherits a place in his father's harbor gang. It also helps if he enters lobstering gradually, putting out a few traps while still a teen-ager, then expanding after high school to become a full-time fisherman. Such a boy learns the culture of the community and the norms of the lobster industry as a part of growing up.

A man will have most difficulty entering lobstering if he is an adult, if he comes from a distant area, and if his family has no connection with fishing. However, the most important single factor in gaining admission to a harbor gang is willingness to abide by local traditions. Any man who acquires a reputation for molesting others' gear, a prime taboo, will not last long regardless of local genealogy or ties.

A number of "outsiders" are presently lobstering in Maine waters. For example, mainlanders and even out-of-staters have been allowed to fish in Monhegan Island territory—ostensibly one of the most difficult places to gain entry into—as long as they presently live on Monhegan, prove willing to abide by the local "closed season," and do not go fishing before "trap day," the day when the islanders begin fishing each year. In fact, in every harbor, a surprisingly high proportion of the lobstermen were not born in the community where they are now lobster fishing.

A part-time lobsterman receives a good deal more hostility than a new, full-time fisherman, even

though full-time fishermen catch more lobsters. In part this prejudice stems from a strong feeling that part-time men are taking unfair advantage by having two jobs. As one man complained, "They have one job, then after they have collected one pay check, they come on out here and take the food out of our mouths." Another common complaint is that part-time fishermen are not familiar with the norms of the industry.

Lobsters are caught in different places at different seasons. In the winter, when the water near shore is very cold, they are best trapped in water over 30 fathoms deep, which is warmed by an inversion effect from the Gulf Stream. As the water becomes warmer with the approach of summer, they can be caught closer and closer to shore so that by mid-June the buoys are often placed within feet of the surf. During late June and July, when lobsters go among the rocks to molt, or shed, lobstering is so bad that some men pull up all their traps; many others leave only a few in the water. As the water cools off, traps are again moved farther offshore.

Traditional lobstering territories are usually no more than 100 square miles, which means that a lobsterman spends most of his life in one small, intimately known area. Even in winter, most men rarely go more than ten miles from their home harbor.

Close to shore, traditional territorial boundaries are clearly demarcated and defended. Farther out, the boundaries become vaguer, so that six or eight miles offshore there are no effective boundaries to speak of. A man from the southern part of the state put it well when he said, "The whole ocean is free if you go out far enough."

While lobstermen will discuss boundaries in terms of major geographical features, such as the Damariscotta River or Pemaquid Point, actual boundaries are usually drawn with reference to minor features—a reef, a small cove, a sand bar, sea buoys—features that have significance only for men intimately acquainted with the area.

Violation of a territorial boundary meets with no set response. An older man, well known in the area, might get away with a territorial intrusion for a long period of time; a younger man, a new fisherman, or an unpopular man might quickly be sanctioned for the violation.

Ordinarily, repeated violation of territorial boundaries will lead to destruction of the offender's gear. It is usual for one man operating completely on his own to first warn an interloper. In some places this is done by tying two half hitches around the spindle of the offending buoys; in other places by damaging the traps slightly. At this point, most intruders will move their traps. If they are not moved, they will be "cut off." This means cutting off the buoy and warp line from the trap, which then sinks to the bottom where the owner has no chance of finding it.

A man who violates a boundary is ordinarily never verbally confronted with the fact of his intrusion, and the man who destroys his gear will traditionally never admit to it. Admitting the destruction of a man's gear could bring retaliation

After hooking his buoy, Philip Davis slips the line around a mechanical lifter. hoists the trap aboard, and removes a lobster.

not only from the lobsterman but from the Sea and Shore Fisheries warden as well. Moreover, destroying another man's gear—even the traps of a known interloper—is considered shameful.

In rare instances, boundaries are defended by group action. It is well known that anyone invading the traditional territories of islands such as Monhegan, Matinicus, and Green Island will meet with coordinated resistance from men fishing in those territories.

Men touch each other's lobster gear only with great reluctance. A would-be aggressor knows that he can easily precipitate an incident in which he would be the ultimate victim. As one man said. "The trick to driving a man [driving him out of the area] is to just cut off one or two traps at a time." This makes it unprofitable for him to continue operating in the area, but does not challenge him to open warfare, especially since, in most cases, he can only guess at who cut his traps.

Periodically, a man whose traps have been cut off will retaliate against the wrong man or men, who do the same thing in return. The result is often a comic opera in which the innocent, along with the guilty, retaliate blindly against each other. Some men cut off traps knowing someone else will be blamed. The potentialities for trouble in such situations are enormous.

Small incidents occur continually, but lobster wars—in which hundreds of traps are cut off—are rare, occurring perhaps once a decade. In fact, when one considers that the entire coast of Maine is patrolled by only a handful of Sea and Shore Fisheries wardens, it is amazing that there is so little trouble. The traditional territorial concepts go a long way in maintaining relative peace.

There are times, however, when a group of men, goaded beyond endurance, will launch a large scale "cut war." These lobster wars may lead to court action, violence, and long-standing bitterness. In Maine's midcoast area such incidents are infrequent, although stories about them are repeated so widely that they give the entire coastal region an unsavory reputation. I recall listening to a group of men gleefully recount how men on one of the offshore islands cut off all of each other's gear in a series of forays; then went around burning each other's docks. Such stories have obvious entertainment value. They also remind people of what can happen when traditional norms are violated.

When trouble does occur, those who can muster the most support usually win. This is true whether the fight concerns territorial violations, attempts to break into a harbor gang, or a personal feud be-

tween two men fishing out of the same harbor. Several times I heard it said that "two men who get to fighting just put each other out of business." The older, well-established men from large families are thought to be particularly "bad to play with." This explains why men like my New York friend have less of a chance of breaking into the business. It also explains why such men must be careful about violating territorial boundaries if they are ever accepted by a harbor gang.

An individual can affect boundaries if he doesn't mind a little trouble and is willing to take the economic losses. As one man put it, "One man who doesn't give a damn can cut off more traps in a night than a dozen men can make and set out in a week." The willingness of an individual to engage in trouble is notably increased if he has some other source of income. One man on one of the offshore islands, for example, maintains a private lobstering area. If anyone invades his area, he merely pulls his traps, cuts off all those of the invader, and works at boat building until the trouble dies down. He said, "That's my area, and if I can't fish there, no one else is going to."

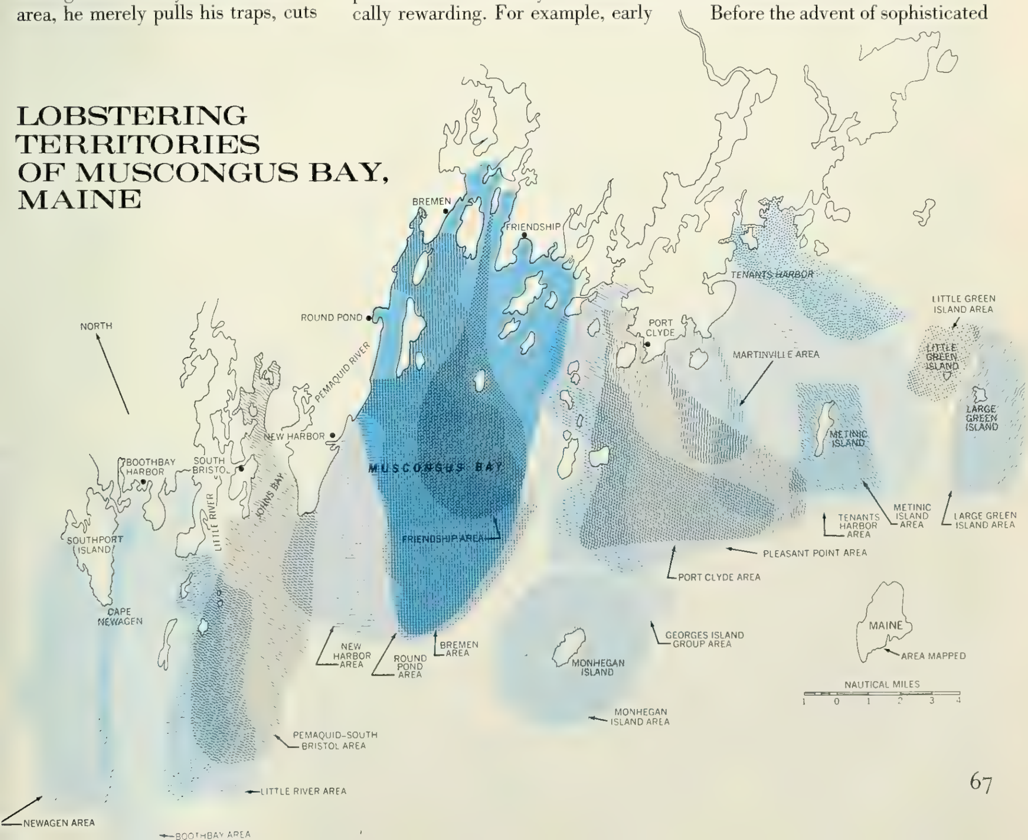
The waters around many of the small, unoccupied islands are the private lobstering grounds of families who have had legal ownership of the islands themselves for generations. These territories are most vigorously defended. In some cases, lobstering is done exclusively by members of the owning family, but in cases where there are not enough family members to utilize the area, other men are allowed to rent lobstering rights. Even these rental rights are inherited, so that men who rent ocean space from a particular owning family are usually descended from previous renters.

Although people are hesitant to talk about catches and incomes, especially those men fishing private island territories, there is some evidence that holding and defending a private island territory is economically rewarding. For example, early in July, 1971, when mainland fishermen were happy to average a half pound of lobster per trap, a man from one of the strongly defended island areas indicated that he was getting much more: "Some of us out here think that half a pound a trap isn't so good. If all I could get was half a pound a trap, I'd go ashore."

On a recent morning I was talking to some friends on a dock as they brought in their catches. One man—who fishes in an ordinary mainland harbor territory, along with about 40 other men—got eleven pounds of lobsters. Another—fishing five miles away in his family's private island area—caught 172 pounds the same day. The ecology of the two areas is slightly different, and both men do not pull the exact same number of traps. Although the differences in catch are not always this dramatic, men lobstering in exclusive island areas consistently obtain higher yields than men fishing out of mainland harbors.

Before the advent of sophisticated

LOBSTERING TERRITORIES OF MUSCONGUS BAY, MAINE

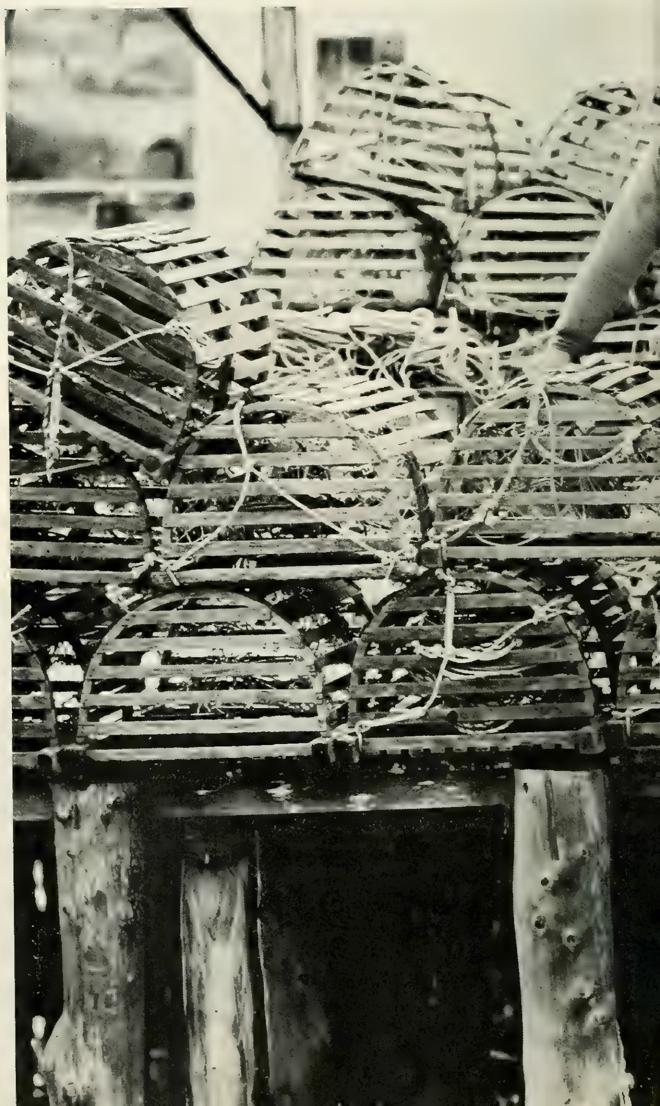


fishing equipment, lobstering territories were small compared with those of today, and boundaries were strongly defended. This pattern was connected to the fishing technology. When fishermen could only gain the intimate knowledge needed for lobstering with a lead sounding line, and could only travel by rowboat or sail, the area that could be effectively fished was limited. Thus, before 1920 the entire coastal waters of Maine were divided into a large number of small territories vigorously defended by their "owners"—often groups of kinsmen.

With the advent of gasoline motors, and more recently with the installation of electronic depth-sounding gear, traditional areas have been growing larger and larger, and the ocean area where mixed fishing is allowed has increased as well. In part, this new technology has allowed men to fish for lobster farther offshore, in areas not claimed exclusively by one harbor. In addition, the new technology also broke down many of the older boundaries. As the capacity to fish a larger area increased, men became much less defensive about maintaining their smaller territories. Moreover, many men seem happy to see some territorial boundaries disappear. As one old man put it, "You might not be too sad to see men invading your area when the fishing was good if you could do the same to him some other time. Both of you might well catch more lobsters that way."

Changes in territoriality relate in very important ways to the major problem now facing the Maine lobstering industry—that of overfishing. In the past few years the number of lobsters caught has decreased drastically, at least a 25 percent decline since 1967. Lobstermen are fully aware of the problem. In their view, the decrease in supply is due to overfishing. One lobsterman said that "the whole problem is due to too many men, fishing too many traps, for too long." This is a simplistic view, for Robert Dow of Maine Sea and Shore Fisheries has evidence that a change in water temperature is one of the factors responsible for the decrease in lobster supply. However, part of the problem is man-made. The number of traps set has increased tremendously. Fifteen years ago, only a few men had as many as 400 traps; the average was well below 200. Now, the average fisherman has perhaps 400, and men with 700 and 800 traps are not uncommon. These increases were made possible by the hydraulic pot hauler.

For the last ten years, the number of lobstermen in Maine has hovered at about 6,000. However, only half of the men who had lobster licenses in 1970 had them ten years previously. This means that a large



One of the most peaceful areas on the Maine coast is New Harbor, where lobsterman Norman Davis rests on the pier.

number of men do not stay in the business for long. But those who leave are immediately replaced by others. It is still difficult to break into a harbor gang and in most places a summer resident cannot go lobstering at all. Nevertheless, the industry is much easier to enter now. When the entire coast consisted of small, strongly defended territories, any stranger moving into an area could expect to be rebuffed by the traditional owners whose income he threatened.

The older territorial system effectively restricted the number of lobstermen. While the system was hard on men attempting to enter the business, it was easier on the lobster as a resource. Even now, those coastal areas that are most difficult to enter, and whose boundaries are strongly defended, continue to provide a sustained yield of lobsters. As one dealer expressed it, "Those islanders are doing all right, and they will continue to earn the highest incomes on the coast as long as the place doesn't get overcrowded."

In comparison, the relatively open areas of the coast where territorial boundaries are weak have suffered from overexploitation of the lobster resource. If lobster fishing and fishermen are to survive in these areas, Maine will have to impose more controls on lobstering. The state would do well, when it prepares new legislation on lobstering, to take into consideration the lobstermen's unwritten rules of territoriality.

The Penitentiary Seals

Continued from page 21

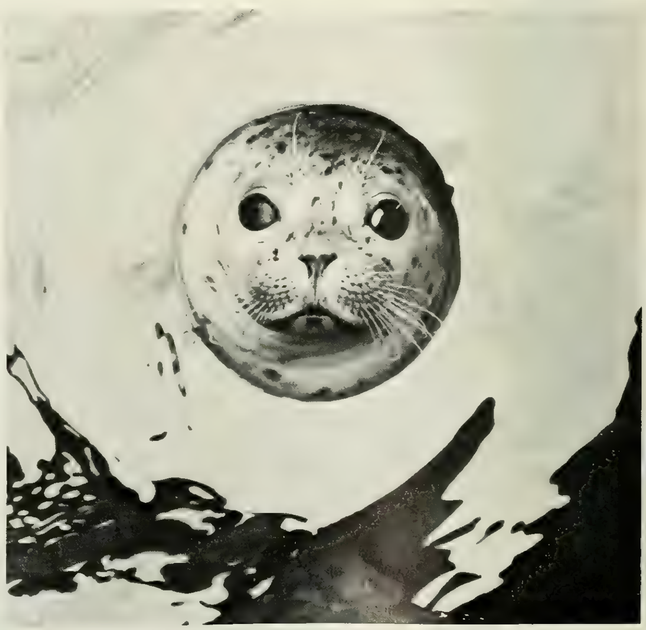
more fish to eat, will the quality of life be improved?" I think not. A Puget Sound without seals would not be Puget Sound.

As I lie in my sleeping bag on the floor of the Gertrude Island tower, I ponder the ways of seals and men. All through the night, some of the animals on the beach below me are astir. The old ones mutter drowsily: now and then a young one calls "kroooh" for its mother. The flood tide reaches the base of the tower and I hear the slop, slop of small waves. There is a hint of voices in the sound, blending with the talk of the animals. I look out the window and see a lovely, greenish luminescence where the surf is reading out its message.

In the bright light of noon, Terry and I eat our lunch beneath a madroña tree and speculate on the ancestors of the harbor seals. They may have been otterlike beasts living in freshwater lakes of Old Asia. From their ranks, pioneers moved down rivers and out among the broken ice of the North Pacific Ocean. For twenty million years, Ice Ages came and went, the level of the sea rose and fell, the Bering land bridges appeared and disappeared—and the seals evolved to meet the changes. Today, in Arctic waters there are seals that give birth to white-coated pups. And today in Puget Sound our own harbor seal gives birth to a silver and black pup. Yet, though the harbor seal can have no memory of its dim, icy past, its unborn young in the womb is clothed for a while in a white, woolly coat, a memorial to a colder time.

When Terry and I return to the mainland we stop to visit the seals in the Point Defiance Aquarium in Tacoma. Here the animals live in outdoor pools of clean, running water pumped directly from the Sound. Small packets of herring are on sale to visitors who want to hand-feed the seals. We watch the begging postures of four animals that have learned individual tricks for winning fish from the custom-

A harbor seal pup several months old, raised in an aquarium.



ers. One pats the water rapidly with his flipper, one raises his body and belly flops on the concrete deck with a loud report like a handclap, another cries "oonh! oonh!" as he waggles his lower jaw. The fourth animal enjoys drenching the spectators with water as though, in the small circular routine of his life, excitement is more important than fish. A man chewing on a dead cigar approaches with a bag of herring, feeds the beggars impartially—and throws the empty bag into their pool.

Here in Tacoma lives the famous Dub-Dub, now in his thirty-fourth year and thought to be the oldest seal alive. I took his picture thirty years ago, when he was a handsome young adult. Now he is blind and nearly toothless, hanging in the water like an old bottle about to sink. According to his keeper and friend, Cecil Brosseau, Dub-Dub weighed 325 pounds at the peak of his career. Though he sired three pups, all were born dead. Long ago, he escaped from his pool and disappeared for three days, then returned to captivity. He was lonesome out there in the Sound, and a little frightened; he had not known that he was a seal.

The inquiring naturalist can learn many things about a seal in a pool. By training instruments upon it, directly or remotely, he can study its animal machinery. He can probe its structure and test its behavior under stress. But only from the seal in the wilderness can he learn other and more beautiful things, where it was formed and where its creation continues. My thoughts return to Gertrude Island.

The night deepens. The trees lose their identity; the black fir forest and the black water merge as one. A cool, damp, briny smell rises from the Sound. The sleepy song of a white-crowned sparrow begins, then fades away. A gull returns on beating wings to a sandbar to rest. Small fishes plop in the shallows, pursued by an unseen enemy. The old-man seal had risen like a poet to illuminate my dark. Though now he is gone, his presence remains for a long time in the night, as if the creature and his world would not be separated. ■

If You Were a Baboon...?

Continued from page 25

protect them as they learn to cope with the challenges of life in the larger group.

Study of this process of baboon growing-up, well documented on film, provides many discussions of the differences between male and female roles in rearing the young, the importance of social learning, and how childhood experiences help shape the sort of person one becomes as an adult. Because the socialization process is relatively simple and visible in baboons (although there is a remarkable variety of roles and "personalities"), children are helped to look at their own growing-up in new ways.

Materials of this kind are not designed to teach children a particular viewpoint about human behavior, but rather, to heighten their awareness that human behavior, while complex, is understandable in some form. By employing certain approaches, such as the contrasting animal case studies, and by developing techniques of observation, children will hopefully arrive at new insights about themselves. Such understanding may even give them a modicum of increased power over their own lives.

Among the materials children read on baboons are excerpts from Irven DeVore's original field notes. At first we thought that young children would be bored by long entries describing tedious field observations, but the field notes proved to be among the most popular reading in the course. This discovery led to the development of an "Observer's Handbook," a journal that children use to take their own field notes on human behavior. Concentrating on play, learning, and aggression, children gather data in the kindergarten, in the playground, and wherever they can find younger children engaged in normal daily activities. They compare these observations in class, discussing them in much the same way they do the baboon field studies. Some teachers have even found ways of extending this first-hand exploratory aspect of the course far beyond what was originally anticipated.

Why did we include the study of Eskimo in the course? What is instructive about a group of human

beings who have managed to survive in what was, at least until space travel, the most alien environment known to man? The answers are obvious. (There are, in fact, intriguing parallels between the effort to sustain life in the Arctic and the problem of survival on the moon—protection against the elements, conservation of limited resources, the need for carefully structured patterns of cooperation, and so forth.) The purpose of the Netsilik Eskimo material is not so much to establish parallels between a remote culture and our own as to explore in an unfamiliar context the dynamics of cultural behavior. Teaching small children about their own social environment is a little like trying to teach a fish about water. Familiarity with the subject gets in the way. Hopefully, by studying about people who seem to be very different from themselves, children can be shown the cultural kinship all humans have in common. Today this is a more important goal than the repeated study of American society that has typically dominated social studies instruction in the schools.

This phase of the course opens with a film. With surprise, the children discover a Netsilik family living, not in igloos, but in caribou-skin tents. The month is August, and there is no snow on the tundra. The camp is located beside a rapidly flowing river, where some of the group are spearing arctic charr behind a stone weir with long, trident-shaped leisters. A man repairs his fishing gear far from camp to protect his luck. A small child pretends to fish with his toy trident near the water's edge. A woman, presumably his mother, braids her hair with decorative strips of fur, and then, mysteriously, places ashes from the fire on the eyes of the recently caught fish she is about to clean.

The class erupts with dozens of questions. Why are the fish swimming upstream? Are they like the salmon? How is the stone weir made? Where do the skins come from? What are the tools made of? How does he know how to make them? Who teaches the little boy? Do men and women do different jobs? Why is the woman putting ashes on the eyes of the fish? Do the women really care about being

pretty? Why are there more men than women? Are they all related?

Even in this brief opening scene, some of the most important features of Eskimo culture are revealed: the centrality of technology, the informal but significant patterns of social life, and the suggestion that behavior may be governed by beliefs. Furthermore, this picture shatters children's typical image of Eskimo life as one of igloos and sled dogs, and draws them into an examination of the variety and complexity of Eskimo culture.

As with the earlier animal studies, much of the information about Netsilik life is initially presented on unnarrated films. The films, created especially for this course, constitute the most complete visual ethnography of another culture ever made. They were produced under the direction of Asen Balikci, professor of anthropology at the University of Montreal. Using these films, together with a children's edition of Knud Rasmussen's Arctic journal of 1923, poems and stories drawn from Eskimo folklore, a brief novel, and numerous booklets and materials covering all aspects of Netsilik life, children reconstruct for themselves a picture of traditional Netsilik culture.

After a brief study of the summer fishing camp, children turn to an examination of the more complicated life at the caribou hunting grounds. It is early autumn and two families are living in tents at the edge of one of the many inland lakes that lie in the path of the caribou as they migrate south across

Figuring out the best way to divide a seal, children appraise the social value of Eskimo sharing patterns.

Simpson Peninsula. Several men are at work constructing strange-looking stone cairns, known as *inukshuks*, which function as decoys for diverting the caribou toward the water. When the herd appears, several beaters chase the frightened caribou into the lake, while two hunters launch their kayaks and swiftly intercept the swimming caribou, spearing them easily in the water and towing them ashore. The kill is then butchered, some of the meat eaten, and the rest stored in a stone cache.

Children simulate the process of the hunt on game boards especially designed to allow them to play out a variety of strategies for hunting the caribou. "Winning" the game involves devising the most effective way to combine hunters, beaters, *inukshuks*, and kayaks to capture the maximum number of caribou. What the Netsilik do in hunting caribou is similar to strategies used by humans anywhere to attain some desired objective. After playing this game, children can discuss how many aspects of human life involve similar plans and strategies.

by David Grinspoon, 5th grade

The dominant male,
Is anything but frail,
He leads the troop,
Which is quite a big group.
The juveniles play,
All through the day.
Baboons have a very
organized life,
And always have a
different wife.

But the examination of caribou hunting is not confined to a study of the tools and strategies of the hunt. Children hear tales of the legendary hero Kaluarsuk, whose prowess as a hunter was drawn from the mystical powers of an ancient paddle, and they learn about the qualities of strength and aggressiveness that produced great caribou hunters in the past. Here children can discuss the extent to which the human qualities valued in a culture are related to behaviors that promoted the survival of that culture in the past. Which of these values are universally human, and which are unique to a particular culture? Is aggres-

siveness always culturally valued?

In winter, Arctic temperatures drop to nearly fifty degrees below zero, and the Netsilik congregate in larger groups. Survival now depends on cooperative hunting of the elusive seal. This "dark time" offers some of the deepest insights into the complexity of Netsilik life and into the mystery of man's humanness. The technology of Arctic survival alone is an extraordinary achievement. Using sleds with runners fashioned from the bodies of frozen fish wrapped in sealskin and bound together with caribou leg bones and skin thongs, families migrate out onto the sea ice and build large communal igloos that will house several families together. Here groups of seventy or eighty people manage to survive and even prosper under conditions that would challenge the full human and technical resources of our own culture.

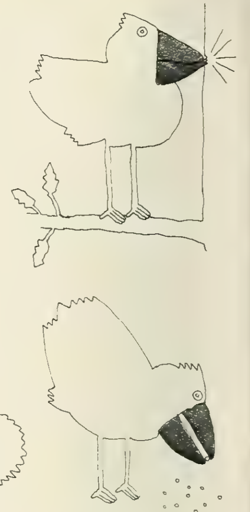
Seal hunting is conducted cooperatively by a group of hunters working as partners and sharing the catch. Since a single seal might have as many as twenty breathing holes stretched over an area of several square miles, cooperation is essential to maximize the possibility of a successful hunt. Using their dogs to locate the breathing place, men insert a long probe into the opening and then cover the surface with snow so that only the small hole made by the probe remains. They then place a "breathing indicator" made from a tiny loop of swansdown and attached to a T-shaped piece of caribou sinew over the hole. After preparing his harpoon and carefully propping it up on two fur-lined supports (to muffle any sound), a hunter takes his place over the hole for his long vigil awaiting the prey. The almost imperceptible motion of the swansdown indicates the presence of the seal and the hunter, in one swift and powerful motion, must then plunge his harpoon down through the snow into the body of the unsuspecting animal. A fight ensues, but the hunter has the edge, and in the end he heaves his heavy catch up onto the ice, where he immediately shares a portion of it with his hunting partners.

The drama of this struggle to sustain human life in such an unforgiving environment is not lost on

young children. They become immersed in the problem of the hunt by playing a game in which they "hunt seals" by removing corks from a board that contains seals that have been distributed randomly among some of the holes in the board. They will "starve" if they fail to catch a seal at least once every five days, and in any group of six children playing, two or three are likely to starve before twenty hunting days have passed.

This leaves the rest of the group with the decision about what they should do. Sharing does not always immediately come to mind, and American children often make deals, or even let their classmates "die" on occasion. Later, they discover that the Netsilik hunt with seal-sharing partners, and that ritualized sharing patterns are maintained between all members of the group to insure that no one starves so long as there is meat in the camp. Children simulate Netsilik sharing patterns by cutting up pa-

A structure can have many functions.



per seals and distributing meat much the way the Netsilik do. This can lead to discussions of when sharing is a desirable social value, and of the different values and social institutions found in societies that stress communal ties compared to those that places strong emphasis on individual autonomy.

Because winter is a difficult time for the Netsilik, this raises questions about the problems a society faces when it simply cannot provide for everyone. In Rasmussen's journal, children read an account of a man named Arfek who faced the hard decision of what to do about his wife's aging mother who could not keep up on the winter trek. Waiting for her meant endangering the lives of his wife and children. Fifth graders are thus confronted with every society's dilemma about how to care for the aged, which naturally leads them into a discussion of how old people are cared for in our own culture. Children are troubled, of course, that a Netsilik man could consider leaving an old woman out in the snow to die, but they ultimately understand the extent of his dilemma. They begin to see problems of this kind, and how cultures grapple with them, in a new perspective. Death becomes a legitimate topic of discussion in the elementary classroom.

The children are also introduced to a collection of ancient songs and myths of Netsilik culture. They hear the legends that tell us so much about how the Netsilik view their world and how they cope with the insoluble dilemmas of their lives. Perhaps the most powerful of these stories is the origin myth, the tale of the sea goddess Nuliajuk, who controls the movement of seals and who bitterly hates mankind. Nuliajuk was an orphaned child left behind by her people in a time of famine when they went to seek new hunting grounds. The people built a raft and as they were leaving the shore, Nuliajuk jumped onto it. But the people pushed her into the sea, and when she tried to hold on to the raft, they cut off her fingers, which turned into seals. Nuliajuk sank to the bottom, where she became mother of the sea and goddess of all sea creatures. From here she controls all animals, on both land and sea. When Eskimo break taboos, she punishes them by hiding the animals and letting the people starve. The Netsilik say she hates mankind for the way she was treated as a little girl.

Some children are deeply moved by this myth and see in it a powerful statement of how the Netsilik give symbolic expression to their continuing struggle to maintain life in their environment. Like many other Netsilik myths and stories, it reveals the plight of the social outcast, the vulnerability of children, and the profound impulse of the Netsilik toward unification of man and nature. The theme of man's weakness in the face of powerful natural forces runs throughout Netsilik mythology; as one informant

said to Rasmussen, "We do not believe; we fear."

Such a strong statement of the Netsilik world view has evoked in some children serious reflection about their own beliefs. What are beliefs? Where do they come from? How do they help to shape a person's behavior? How can people who espouse a variety of beliefs learn to accommodate their differences?

In a culture such as the Netsilik, in which people share a common set of beliefs based on similar conceptions of the world, it is easy to see how bonds are established against those forces that constantly threaten human life. In a culture as complex as our own, where diversity of belief is not only tolerated, but these days even encouraged, children face the critical problem of giving order to this increased complexity. For young children who have become increasingly aware of the cultural differences within American society and whose knowledge of the world beyond our shores is growing, discussions of how others interpret their world can help them appreciate the meaning of their own beliefs. Children learn that Netsilik myths and legends impose a poetic order on the deepest of human problems, an order that can be as spiritually satisfying as the most elegant scientific explanation. Furthermore, tales that first appear strange often have a counterpart in our own lives: one legendary hero, Kiviok, reminds us of Paul Bunyan and the more frightening Eskimo stories sound like passages drawn from the Old Testament.

But perhaps the most important consequence of talking about Eskimo beliefs in the classroom is the legitimization of the discussion of beliefs itself, as opposed to the promulgation of particular beliefs. School should not be the place to indoctrinate beliefs—certainly not in a society that professes to value diversity. Fear of indoctrination, however, has sometimes led some teachers to avoid the subject of beliefs altogether, as if human values were less important to know about than the names and dates of wars and presidents. Through the Netsilik study, "Man: A Course of Study" has attempted to create a legitimate forum for the

comparative study of beliefs and to help children learn how beliefs influence human behavior.

Public response to "Man: A Course of Study" has been mixed. We knew from the beginning that it was a risky enterprise, given the conservatism of most social studies programs. We were not surprised, therefore, when dozens of publishers passed up the program as "too controversial," or "our competitors would make issues of the concepts," even after the course received a commendation from the American Educational Research Association and the American Educational Publishers Institute in 1968.

Now that the program is being distributed nationally, the judgment of the commercial textbook houses remains an open question. Many American parents do not want their children comparing human behavior to that of other animals, and some are even skeptical of a social studies program that immerses children in the study of another culture. Some of this questioning represents an honest public debate of the purposes of social studies teaching in the schools. Is it proper for children to engage in study that may lead them into frank discussions of sex, starvation, and violence? Should schools expose children to an evolutionary perspective on human behavior that may call into question religious teachings? Does teaching about a culture that permits senilicide under certain circumstances undermine children's faith in the perfectability of man? And what about the problem of cultural relativism—will the presentation of another culture on an equal footing with our own erode children's faith in the American way of life?

Open public debate on such questions is probably the best way to develop guidelines for the social education of the young, especially in an era when our survival may depend on a deeper understanding of human behavior than we have managed to achieve through social studies teaching in the past. But the intensity of the controversy that "Man: A Course of Study" has stirred in some communities raises questions about whether such issues can, in fact, be aired in a constructive, reasonable way. Recently in Phoenix, Arizona, more than 700 people attended a special school board meeting to debate whether the course should be offered as an optional elective to 120 students in one elementary school. Prior to the meeting the State Superintendent of Public Instruction banned purchases of materials in the state until the case was settled, and one local politician threatened to introduce a bill in the state legislature barring the materials on the grounds that by exposing children to evolutionary theory, "Man: A Course of Study" was introducing religious teachings into the schools.

Political maneuvers of this kind on the part of public officials are not likely to encourage a frank exchange of views on how to improve instruction in the social sciences. In such an atmosphere it is safer to press on with the incontestable facts of geography and to tailor history teaching to the requirements of patriotism. Yet, as our crowded planet grows smaller by the day, these are shortsighted views. The best protection against irreconcilable human conflict for the next generation of American adults may be, not to deepen our patriotism, but rather to understand the fundamental humanity that all people share. ■

Seal Song

by Alexis Rosenoer, 5th grade

Come up,
Come up to the soft air.
A-h-h-h
So clear
So soft
White clouds above.
The wondrous world on top.
Soft white snow
Cool, crisp air.

Breathe,
Breathe soft air
Breathe low hills
Breathe sweet air.

Love
Love the air
Love the low hills
Love the white snow,
crisp and sparkly
Love the gulls up above—

But be careful!

Person to Person

Anthropologists (past NATURAL HISTORY authors) offer friendship and a sympathetic ear.

DOING FIELDWORK, by Rosalie H. Wax. *The University of Chicago Press, $10.50; 395 pp.*

About to leave college to conduct her first field work and bursting with enthusiasm, Rosalie Wax paid a farewell call upon one of her professors, the great anthropologist Alfred L. Kroeber. She expected to hear words of profound intellectual counsel and inspiring cheer, but Professor Kroeber chose instead to discuss such mundane matters as heat, dysentery, and loneliness. Somewhat disconcerted, Wax tried to assure Dr. Kroeber that she was adequately equipped to cope with the practical side of field work by remarking that she was taking along vitamin B tablets to help her adjust to the heat, to which Kroeber quietly replied, "I think you may need more than vitamin B."

Among anthropologists, field work means conducting research in a society and culture different from one's own. For a beginner, the first experience in the field is regarded as the final test of his professional competence. The novice is exceedingly vulnerable and under great tension, for his professional image is at stake. Failure does not bear thinking about. The whole experience takes on an almost mystical quality, and many anthropologists think that field work can, or should, change one in some fundamental way.

In this context then, Kroeber's laconic remarks to Wax on the verge of her plunging into the quintessential anthropological experience exemplify one of the curious paradoxes of anthropology: the reluctance and/or inability of the experienced professional to explain to the novice what field work is really like. Many young anthropologists go into the field, as Wax did, ill prepared technically and intellectually and with absolutely no idea of what to expect in the way of practical difficulties. Perhaps this is because field situations differ so much that many field workers doubt that their own experiences can be generalized; perhaps they still fear to reveal to students and colleagues their doubts, shortcomings, and failures; or perhaps the major problems are not technical or intellectual but broadly human and deeply personal, so that veterans despair of being able to say anything particularly helpful to the novice.

"Loneliness, boredom, and frustration," writes Wax, "are intrinsic to the field situation," and in discussing the "touching" notion that people of another society will be less selfish, greedy, and bigoted than those of one's own, she comments, "I have no advice on how to live graciously through the experience of being exploited, hoodwinked, short-changed, blackmailed, robbed, or fooled, except by bearing in mind that every fieldworker could furnish [similar] examples."

What, then, can the experienced anthropologist offer the novice to

"The fieldworker who involves himself closely with people at the top may be sure they will never let him get near the people at the bottom."

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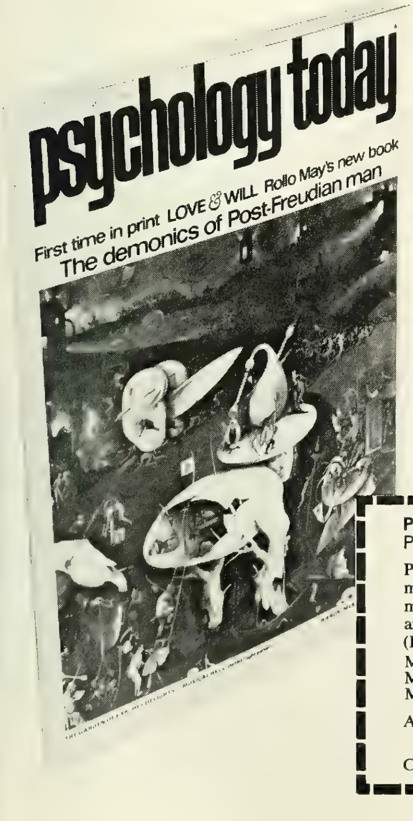

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"One can learn a great deal from people one dislikes or from people who dislike one."

help him cope with the frustrations, disenchantments, and practical difficulties of field work? From her own experiences in the field, Wax believes that the realization that even the most competent anthropologists often have considerable trouble can have remarkably therapeutic effects upon the discouraged field worker. He then realizes that he is not unique; the same thing has happened to others. This is the key to Wax's approach: she describes in detail her experiences in conducting three major field studies, emphasizing all the things that went wrong and her strategies for setting them right. Since all her field trips were difficult, one exceptionally so, she has a substantial fund of illustrative material.

Doing Fieldwork consists of four parts, starting with an introduction that discusses, among other matters, the theoretical presuppositions of field work and its historical background. This is followed by lengthy accounts of her three studies—one in the Japanese-American Relocation Centers of World War II and the other two among North American Indians.

Wax undoubtedly became interested in the problems of field work as a result of her first field experience in the relocation centers in the 1940s. A more trying research situation would be difficult to imagine. She was asked to study people who, having committed no crimes, no acts of treason or espionage, were uprooted from their homes and occupations; then confined behind barbed wire fences patrolled by armed soldiers. They had been subjected to venomous propaganda from powerful politicians and newspaper columnists, and many had suffered irreparable economic losses. Could such people be expected to welcome a field worker, a non-Japanese, who wished to record their words and deeds?

Wax reports that two months of hard work accomplished nothing and that "I began to see myself as a total failure. The anxiety I suffered was so agonizing that I still find it hard to describe. Every time I returned to my stifling room after a series of futile 'interviews' I sat down and cried. . . . I fought a losing battle with an obsessive desire to eat. . . . In three months I gained thirty pounds."

After a few months, however, even this emotionally tense field situation yielded to rather routine methods. Wax began to interview people on a variety of commonplace subjects having no connection with evacuee attitudes toward the delicate matters that really interested her. Many people were happy to chat, for life in the relocation centers was dull, and Wax's visits provided relief from the monotony. These interviews inevitably led to gossip and discussion of recent events, the sort of thing that Wax wanted to hear, and gradually she began to gather considerable information. Some of her respondents became quite friendly and began to devote a good deal of time to helping her. At this point, her study was successfully launched.

The technique Wax used is so prosaic that it may appear to be no method at all, yet it works because it is soundly based on highly valued personality characteristics, namely, humility, discretion, patience, humor, and nonaggression, and upon a fundamental principle of interpersonal interaction, mutually profitable exchange. Although it may seem that Wax was exploiting friendships to obtain data, she was offering something equally valuable in return: a sympathetic ear, a respectful attitude toward Japanese values and points of view, relief from boredom, and friendship. Both Wax and her informants were well aware of what was going on.

There is nothing humorous in Wax's account of her work in the relocation centers, where misery and tension exploded into violence and murder. In her next field experience, however, on the Thrashing Buffalo Indian reservation, the principal problem she faced—being fooled, exploited, and frustrated by a clever Sioux family—was the sort of thing that can strike an outsider as funny. The classic predicament of the city sophisticate being duped by canny country people, complicated in this case by the efforts of their hostess to seduce Wax's hus-

band, is hilarious to everyone except the victim who watches precious research time slip away without accomplishing anything. Yet during the period that Wax and her husband were being effectively frustrated by their Indian hosts, they were actually accomplishing something important: they were giving other Indians the opportunity to observe them in a difficult situation and to decide what kind of people they were. Finally, another Indian family came to their assistance, and their problem of getting started was quickly resolved.

A third field experience, among the Six Friendly Tribes, illustrates yet another problem: the sorts of difficulties that hostile government officials can cause. In such cases one can quickly become bogged down in an almost incomprehensible political morass. This may be the most difficult problem of all, for one is faced with organized opposition backed by power. When this happens, the field worker needs powerful backing and luck. Dr. Wax and her husband had some of both and they managed to do their work among the Friendly Tribes.

Although Wax's book is by far the best that I have read on the problems of anthropological field work, the wisdom she has distilled from a professional lifetime need not be of interest only to anthropologists. Much of her advice could be absorbed profitably by anyone faced with the necessity of getting something accomplished in a strange society or, for that matter, in his own. *Doing Fieldwork* will inevitably be much more meaningful to those who have undergone an intense experience in a foreign society than it will be to novices; the latter may even be tempted to scorn Wax's matter-of-fact counsel, for she rejects the romanticism, moralism, pseudoheroism, and self-delusion that characterize the approach of some anthropologists. The field worker needs a good deal of luck (Wax justifiably emphasizes this point), he must keep his wits about him, and he must not deceive himself, for his hosts will realize it and consider him a fool. Ultimately he needs the cooperation of his hosts.

"The great feat in most field expeditions, as in life," says Wax, "is to find the areas in which a mutual

or reciprocal trust may be developed. That these areas will be new or odd to both hosts and fieldworker is very likely. But it is in these areas of mutual trust and, sometimes, affection, that the finest fieldwork can be done. . . ."

Stanley A. Freed is chairman of the Department of Anthropology at The American Museum of Natural History.

ZAKROS: THE DISCOVERY OF A LOST PALACE OF ANCIENT CRETE, by Nicholas Platon. *Charles Scribner's Sons, $19.95; 345 pp., illus.*

At the beginning of the century, Sir Arthur Evans uncovered, on the island of Crete, the ancient palace of Cnossos celebrated in Greek mythology as the home of King Minos, and he named its Bronze Age civilization Minoan. While Sir Arthur worked near the center of the island, another Britisher, David Hogarth, was making preliminary explorations in a long-dead harbor town at Zakros on the eastern tip of the island. Evans worked for years uncovering and restoring the great palace of Minos; Hogarth, however, after disinterring some comparable architectural remains at Zakros, left that promising site. It lay untouched, except by local scavengers, for almost sixty years until Platon, a specialist in Cretan prehistory at the University of Thessaloniki, financed by the American Leon Pomerance, began full-scale excavations that are still in progress. In this work Platon gives the first book-length, popular account of the dig at Zakros, the modern name of the region that once held, nestled in the valley opening onto the sea, a splendid Minoan palace complex.

Only one-third the size of Cnossos, Zakros is an impressive, rambling residence built by a local prince about 1600 B.C. With a strong merchant marine at its command, the Minoan town girdling the palace concentrated its industry on the harbor where ships weighed anchor for Egypt and the Near East. The merchants of Zakros sailed their shallow-draft freighters loaded with the local cypress wood to the timber-hungry builders of Egypt. Great jars (*pithoi*) of Cretan oil, wine, aromatics, resins, and, perhaps, honey lined the bulkheads of the ships plying the eastern sealanes. In the harbor of Zakros, so securely shielded by the Minoan navy that land defenses were never built, were unloaded ivory from Syrian elephants, metal ingots, and the Phoenician *Murex*—raw materials for the carvers, smiths, and dyers of the royal workshops. For about one hundred years the town complex prospered, until a major, still unspecified catastrophe overtook it.

The destruction of the palace was followed by its rebuilding, and the vigorous Minoan society thrived although portents of doom were carried on the Aegean winds. Rumblings from a distant volcano—about 75 miles from Crete—and floating pumice debris from its eruptions washed up on the harbor town. In 1450 B.C., this volcano, the heart of the island of Thera, disappeared in a last titanic convulsion. The island collapsed and left a ring of jagged peaks covered by 100 to 200 feet of ash and pumice, indicating a geologic catastrophe four times greater than that of the terrible eruption of Krakatoa in the Pacific. The resultant tidal waves rolled across the Aegean, sweeping the coastal regions of Crete; the sky over Zakros was blackened with fumes and ash. The citizens of the town, like their countrymen at Cnossos, had time to snatch up only their most precious belongings before fleeing inland. The palace was pounded by the tidal surf, ash choked the soil, and flames—feeding on timber and stored oil—completed the devastation. So savage was the destruction that, except for the occasional squatter, men did not resettle at Zakros until the modern farmer came to till the land.

Thus runs the history of Zakros as tentatively reconstructed by Platon from the archeological evidence. Further excavations will certainly modify and enlarge it, but extensive geologic probings, still under way, will be needed to corroborate the suggested tragic connection between the collapse of Zakros and the destruction of Thera.

BERNARD GOLDMAN
Wayne State University

The Immortal Carrot

Continued from page 16

ducing the fleshy root the first year and the flower and seed stalk the second. Yet carrot tissues isolated by these two men thirty-five years ago are still living in culture in several laboratories around the world. As far as we know, these plants are potentially immortal.

The medium for plant tissue growth must have the usual mineral salts required for the growth of all plant tissues, plus a source of carbon, such as sucrose, for energy and the building up of carbon skeletons.

Only two additional substances are required: these are plant hormones, known respectively as auxins and cytokinins. Although they are present in only infinitesimal quantities in tissue, a balanced supply of these hormones is absolutely required for the normal growth and development of plant cells. It was discovered in the late 1940s that changing the relative concentrations of auxin and cytokinin leads to the development of different growth patterns in cultured tissues. An excess of auxin with respect to cytokinin in the medium, for example, leads to the initiation of roots. Similarly, an excess of cytokinin leads to the development of buds. A ratio of auxin to cytokinin between these two extremes favors the development of undifferentiated plant tissue, called callus.

Knowing these facts, a scientist can take a bit of tissue from almost any plant and grow it in a flask in his laboratory. Furthermore, he can at will regenerate the entire plant by changing the hormone concentrations so that roots and stems form. Using this technique, several investigators have grown entire plants from small explants of tissue. The newly formed plants were normal in all respects, including their capacity to produce viable seeds.

As smaller and smaller bits of tissue were used in the experiments, it was ultimately demonstrated that only one cell is required for the regeneration of an entire organism. This is definite and elegant proof that within the genetic material of each cell there exists the complete blueprint for the development of the entire organism.

On a practical level, the demonstration that a single cell or small

groups of cells can be used to propagate many copies of an organism is useful in the creation of plant strains where seed production is a long and complicated process, as for example, with many forest trees. If, from a single young seedling, tissue is excised and grown in culture and then bits of this tissue are made to differentiate roots and buds, propagable seedlings can be produced with a tremendous saving in time. Some valuable genetic material has already been introduced into agriculture through this technique, and it is likely that the process will be extended greatly in the future.

A second approach to breeding plant strains also uses the tissue culture technique, but, in effect, avoids one of the results of sex. The cells of the higher green plants, as well as those of higher animals, are predominantly diploid, that is, they contain two complete complements of chromosomes. One set is derived from the maternal side of the cross, one from the paternal. In such diploid cells, a mutation or other genetic transformation in a chromosome of one set is apt to be difficult to detect. For example, a mutation in the maternal chromosome may be screened by the unaltered homologous chromosome of the paternal set. This problem can be overcome by using haploid tissues, which contain only a single set of chromosomes.

It has recently become possible to cultivate haploid plants with comparative ease. To do this, you start with haploid cells. At certain stages in the development of the pollen-producing anthers of flowers, pollen grains or their immature microspore forms may be removed and induced to grow. These are comprised of haploid cells. Thus in certain plants, especially those belonging to the Solanaceae family (including tobacco, potatoes, and tomatoes), young anthers may be cut from the flower, carefully sterilized, and placed in nutrient media. In some cases, the anther will respond by forming tissue, which is haploid. Under stimulation and control by appropriate ratios of auxin and cytokinin, such tissue may produce entire haploid plants.

When such cultured haploid cells are exposed to radiation or mutagenic chemicals, in most cases the mutation can be detected immediately. Tissue of mutated cells usually produces an abnormal product or develops an abnormal nutritional need, such as for a preformed amino acid or vitamin. Thus, the change in the chromosome can be quickly specified, and once such changes are characterized, the tissue may be further treated to yield economically important products.

But most haploid plants are small and weak, and do not yield well. So it is desirable to double the chromosome number, restoring the diploid state. This can be accomplished through the use of the drug colchicine, which is obtained from the crocuslike plant *Colchicum autumnale.* This drug causes polyploidy, in this case diploidy. Under its influence, chromosomes divide but do not separate into two nuclei. Starting, therefore, from a haploid pollen grain, a scientist can detect or induce a genetic change; if this genetic change is desirable, the plant can be diploidized through the drug colchicine, and a new strain of diploid plant obtained rather quickly. At present, not all plants have been successfully treated in this way, and it remains to be seen whether all of them can, in fact, respond to the same techniques.

The creation of new plant strains from a small amount of tissue, from a grain of pollen, or even a single cell may be difficult to imagine, but scientists are already taking another step—they are going inside the cell to build new strains of life. But that subject will be discussed in a future column. ■

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6-12—Murray Tinkelman
14—Steve Myers
18-21—Victor B. Scheffer
22-24—Education Development Center, Cambridge, Mass.
27-37—AMNH
39—Norman Myers, Bruce Coleman, Inc.
40-41—top, Norman Myers, Bruce Coleman, Inc.; bottom, George B. Schaller
42—George B. Schaller
45—Frank Drake, and Carl and Linda Sagan, Cornell University
46-47—Helmut Wimmer
51—Reynold Ruffins
52-53—Walter Auffenberg
54-59—J. A. Kern; except map—AMNH
60-69—Douglas Faulkner; except map—AMNH after Acheson
70—Victor B. Scheffer
74-81—Education Development Center, Cambridge, Mass.
82—AMNH

Suggested Additional Reading

THE PENITENTIARY SEALS

SEALS OF THE WORLD. J. E. King. Trustees of the British Museum (Natural History), London, 1964.

THE HARBOUR SEAL IN BRITISH COLUMBIA. M. A. Bigg. *Bulletin* 172, Fisheries Research Board of Canada, 1969.

GREY SEAL, COMMON SEAL. R. M. Lockley. October House, Inc., New York, 1966.

IF YOU WERE A BABOON . . . ?

THE RELEVANCE OF EDUCATION. J. S. Bruner. W. W. Norton & Company, Inc., New York, 1971.

FANTASY AND FEELING IN EDUCATION. R. Jones. Harper & Row, Publishers, New York, 1970.

PEDAGOGY OF THE OPPRESSED. P. Freire. Herder and Herder, New York, 1970.

THE FIERCE AND EROTIC GODS OF BUDDHISM

TIBET, LAND OF SNOWS. G. Tucci. Stein & Day Publishers, New York, 1967.

RELIGIONS OF TIBET. H. Hoffman. Fernhill House, Ltd., New York, 1961.

ART OF BURMA, KOREA AND TIBET. B. Griswold et al. Crown Publishers, Inc., New York, n.d.

ICONOGRAPHY OF TIBETAN LAMAISM. A. K. Gordon. Paragon Book Reprint Corp., New York, 1967.

PREDATORS OF THE SERENGETI

SERENGETI SHALL NOT DIE. B. and M. Grzimek. Hamish Hamilton, London, 1960.

PREDATORS AND SCAVENGERS. R. Estes. *Natural History Magazine*, February and March, 1967.

THE SPOTTED HYENA. H. Kruuk. University of Chicago Press, Chicago, in press.

NEW BEACHES FROM OLD BOTTLES

OCEANOGRAPHY. P. K. Weyl. John Wiley & Sons, Inc., New York, 1969.

ORIGIN OF SEDIMENTARY ROCKS. H. Blatt, G. V. Middleton, and R. C. Murray. Prentice-Hall, Inc., Englewood Cliffs, in press.

THE DEVELOPMENT OF THE AMERICAN GLASS INDUSTRY. P. Davis. Russell & Russell Publishers, New York, 1970.

KOMODO DRAGONS

ORA—GIANTS OF KOMODO. F. W. King. *Animal Kingdom: Bulletin of the New York Zoological Society*, August, 1968.

DRAGON LIZARDS OF KOMODO. J. A. Kern. *National Geographic*, December, 1968.

DRAGON LIZARDS OF KOMODO. W. D. Burden. G. P. Putnam's Sons, New York, 1927.

TERRITORIES OF THE LOBSTERMEN

ABOUT LOBSTERS. T. M. Prudden. The Bond Wheelwright Co., Freeport, 1962.

WINTER ON MONHEGAN. R. J. Siegler. *Atlantic Monthly*, January, 1963.

LOBSTERMAN, STILL FREE. J. Gould. *The New York Times Magazine*, August 20, 1961.

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The American Museum of Natural History

Gardner D. Stout, President — *Thomas D. Nicholson, Director*

Vol. LXXXI, No. 5 May 1972

COVER: *Without the protection of the anemone's tentacles, the life of the shrimp* Periclemenes yucatanicus *on a Curaçao reef would be perilous—and probably a lot shorter.*

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Authors

Believing that there is more to the sensory dominance of vision in American culture than meets the eye, folklorist **Alan Dundes** has taken a hard look at the evidence for visual bias. A professor of anthropology and folklore at the Uni-

Alan Dundes

versity of California at Berkeley, he has conducted on-site cultural observations of the Florida Seminole and the Potawatomi of Kansas. His plans include a field view of the Palio (festival) in Siena, Italy, and a study of the "founders of folklore." His Ph.D. in folklore was earned at Indiana University.

Because of an increase of dog bite cases and the growing threat of rabies from wildlife, Dade County, Florida, created the post of public health veterinarian last year and hired **Norman Frank** to fill it. A doctor of veterinary medicine from the University of Pennsylvania, he had spent a postdoctoral year at the University of Wisconsin comparing cell changes in human and animal diseases, and had established a private veterinary practice in New Jersey. As part of his new duties, Frank is investigating the current rabies epidemic among Florida's raccoon population.

Norman Frank

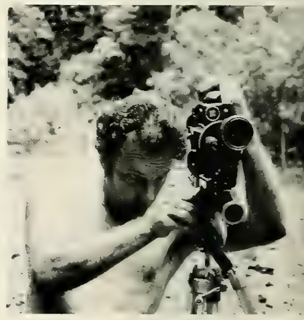
Three years ago **Carl Roessler**, then director of computation at Yale University, decided a change in life-style was in order and took leave of the ivy and smokestacks of New Haven. With his wife, Mary, below, and two children, he headed

Carl Roessler

south and kept going until they found what all thought was a good spot for another beginning—the island of Curaçao. There, in his new occupation as guide for groups of divers and underwater photographers, Roessler has had ample time to pursue his avocations, photography and writing. He also serves as a consultant to the Caribbean Marine Biological Laboratory on Curaça[o] when not busy squiring neophyte[s] around the coral reefs.

Roessler was assisted in his re[-]search on cleaner shrimp by **Jan[-] kees Post**, a student of marine biol[-]ogy at the University of Leiden, Netherlands. Post, who spent last summer in Curaçao working on [a] reef conservation project at the lab[-]oratory, helped to identify many of the organisms encountered on the dives made during the course of the study.

The overpowering presence of a rain forest has been experienced as a green hell by many who have ven[-]tured into one, but **Charles L. Hogue** found more poetry than menace in the complex environ[-]ment all too often dismissed as mere jungle. "The Greening of Doctor Hogue" occurred on a re[-]cent trip to Costa Rica where he studied tropical ants. Senior curator



Charles L. Hogue

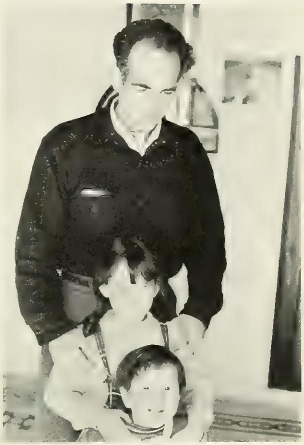
of entomology at the Natural History Museum of Los Angeles County, Hogue already had a sizable storehouse of indelible impressions of that moist and shadowy realm from previous field trips to Central and South America and East Africa. His research on these expeditions involved the biosystematics of primitive aquatic flies and the insect associates of land crabs. His book, *The Kingdom of the Ant*, from which his article is excerpted, will be published in June as part of The American Museum of Natural History's New Explorer series.

In an effort to learn more about the sun, **Jay M. Pasachoff** has conducted detailed observations of the visible solar surface. As a research fellow at the Hale Observatories in California, he is doing research on solar spectra at the Big Bear Solar Observatory. Using the 100-inch telescope on Mount Wilson and the 200-inch reflector on Palomar, he is

Jay M. Pasachoff

also studying the more distant stars. For his next project, he will go to Prince Edward Island, Canada, to observe the total solar eclipse scheduled to enshroud the area for more than two minutes on July 10. He will also supervise a group of amateur astronomers at the site. Pasachoff, who received a Ph.D. in astronomy from Harvard University, will join the faculty at Williams College this summer and assume the directorship of the Hopkins Observatory there.

The annual emigration of thousands of Spanish men in search of work could be expected to indicate a culture under heavy stress, a supposition that led **Jerome R. Mintz** to spend three years in Spain analyzing the causes and effects of this phenomenon. An associate professor of anthropology and folklore at Indiana University, where he also earned his Ph.D., Mintz is preparing a series of ethnographic films based upon his work and writ-



Jerome R. Mintz

ing a book on the rise of anarchism among the peasants in Andalusia. His son and daughter, above, who accompanied him to Spain, proved assets in helping to establish rapport with the villagers: children are loved everywhere. Mintz has previously studied oral traditions of the Hasidic communities of the New York City area, and of the Hopi Indians of Arizona.

M. Philip Kahl has traveled over a good part of South America in an attempt to study the ethology and ecology of that continent's flamingos. As of this writing, he is

M. Philip Kahl

still on the track of the bird's nesting grounds, but his wife reports that flights over most of the lakes in Bolivia, Argentina, and Chile have yet to reveal the nests' locations. His account of the African flamingos in this issue is the result of earlier, more successful journeys. Kahl, who plans to continue his flamingo studies (should he ever find them), wrote "The Courtship of Storks," for the October, 1971, issue of NATURAL HISTORY.

Fathead minnows, those little fish appreciated mainly by fishermen for use as bait, have found an admirer in **Vicky McMillan**, who studied their reproductive behavior. A graduate biology student at the University of Saskatchewan, she has also examined dragonfly behavior in the boreal forests of northern Saskatchewan. With her biolo-

Vicky McMillan

gist husband, Bill, she is now leaving the formal academic life for several years of travel in a live-in van, which will enable both to do field research and free-lance writing. Their first stop will be the Maritime Provinces of Canada where they plan observations of intertidal animals; then to southern Florida to study territoriality in butterflies. A children's book on midges is also in the works.

Letters

More on Lead

In your December letters column, you rendered a fine service to your readers by tracking down the source (the Lead Industries Association) of an article in a Tennessee newspaper saying atmospheric lead is harmless. You might have done well to give us a comparably thorough report on the sources for your own lead article ["Greetings from Los Angeles," by Ira J. Winn, October, 1971] and for your author's long letter in your December issue.

The letter refers to a National Research Council press release . . . and the author states: "And to top off the simplistic nonsense that was handed out to the press and widely circulated, the NRC release—in part written by a former employee of one of the world's leading producers of lead additives for gasoline—noted that 'only young children and certain groups of workers face potential health hazards from airborne lead.' Perhaps to the polluters and profiteers, *only* is a nice clean adjective to place in front of lead-poisoned children."

But our press release did not use the word "only." What it said was: "The high concentration of lead in the air of central cities constitutes a potential health hazard to young children and certain groups of workers but poses no identifiable current threat to the general population." The release was written by one of my associates and me. Neither of us has, to the best of my recollection, ever been employed by a producer of lead additives for gasoline.

Brad Byers
Public Information Officer
National Research Council

And the Author Again

To a large extent, the news release reflects the skimpy treatment of lead danger in the National Research Council's report, *Airborne Lead in Perspective,* upon which the release is based. But the news story itself compounds the problem by artless writing that can only further distract the public from the seriousness of the airborne lead problem caused largely by motor vehicles using leaded gasoline.

Tsaihwa J. Chow, a scientific specialist on lead at the Scripps Institution of Oceanography, who is listed as a consultant and contributor to the original report, declares that people were badly misled by the NRC news release, which he calls "simplistic and overly optimistic."

True, technically speaking, the NRC press release never used the word *only* in stating that there is a potential health hazard to young children. But *only* is implied in their statement, and, in fact, that word was tagged on not only by this writer but also by other people and reporters who picked up and spread the release story. The sentence in question reads: "The high concentration of lead in the air of central cities constitutes a potential health hazard to young children and certain groups of workers *but poses no identifiable current threat to the general population*" (italics mine). The implication is clear that *only* children and certain workers are faced with a health hazard.

Finally, to clarify one point. A former employee of the Du Pont company has been identified in several news stories as the scientist who wrote the epidemiological study portion of the report. The sentence in my letter should have begun, "The NRC study (not the release), in part written by a former employee of one of the world's leading producers of lead additives for gasoline. . . ." The NRC press release people had nothing to do with this particular issue and I regret any implication otherwise. I do feel, however, that the over-all tone of the press release conveyed a false sense of ease to the general public, and that is the key to my letter.

Ira J. Winn

Up in Arms

Although I find Marvin Harris's ideas on the origin and function of warfare ("Warfare Old and New March, 1972) fascinating, I al find them highly speculative. Ha ris's conclusion—that warfare is n associated with instinct—is u founded. Certainly, he fails "prove" his conclusion. Since Ha ris objects to the view that we go war because of our aggressive an mal instincts, I recommend he d lete the word *animal* so that reads "because of our aggressive i stincts." He may also wish to dele the term *aggressive* because hu mans often become involved in wa fare for protective reasons.

However, the "urge" to prote ourselves, our possessions, interest territories, and beliefs is somethin we are born with; it is purely in stinctive *in origin.* Because it is, w place so much value on protectio (or security) that we become aggres sive about it and employ just abou every cultural means—includin bombing raids halfway around th globe—in an effort to guarantee i Not only warfare, but probably ev erything we do—biting our nails mowing the lawn, or holding up bank—is at least to some degree de termined by, or based on, our in stincts. Careful observation of chil dren's behavior, for example suggests that each and every activ ity (normal) people engage in serve the purpose of satisfying one o more of our basic needs: the need for identity, security, and stimu lation (to use Robert Ardrey's ter minology).

Because our instincts are an integral part of us (*see* "The Elephant Man," March, 1972), we cannot detach ourselves, our thinking, or our behavior from them. No matter how often we are told to "love thy neighbor," the overwhelming majority of humans will remain egocentric, selfish, and narrow-minded, and groups will remain ethnocentric. Sermons and philosophies cannot change human nature. For this reason, I contend that if it *seems* that some of our actions are not associated with our instincts, the likely reason is that we fail to see the obscure connections that (must)

exist between our hidden, innate tendencies and our behavior.

HENDRIK JAN REITSMA
Department of Geography
University of Georgia

While I read with interest "Warfare Old and New," by Marvin Harris, I have a number of objections. Man's warfare is indeed unique; no other animal engages in our organized and massive intraspecific (or interspecific) slaughter. However, most, if not all, animals express their aggressive tendencies in a unique, characteristic, species-specific fashion. The howling monkey in the forest, the herring gull along a coastal beach, the three-spined stickleback in the water all have species-specific aggressive displays. To fully understand a behavior, one must examine an animal's habitat, its history, both individual and species, and its physical characteristics. Culture, then, should not be viewed as the cause of war but as one of the factors contributing to its mode of expression.

Warfare has probably served many functions over the centuries: economic, ideological, emotional, and the control of population. Given, however, that warfare exists in so many varied cultures, that it has existed throughout history, and that no one function or group of functions can account for all of its occurrences, I think we should look at the nature of man for its ultimate cause and function.

JEFFREY J. STERN
Department of Psychobiology
University of Michigan

Subjects for Future Columns

I read with interest Arthur W. Galston's "Attitudes on Acupuncture"(March, 1972). It was, however, most difficult to get past Mr. Galston's second sentence: "Impressed by the obvious improvements in the physical conditions of life of the Chinese people; by the virtual abolition of hunger, disease, floods, and drought. . . ."

Those are measured words of immense import and scope. I presume Professor Galston meant them and meant them to be taken seriously.

If that is the case, I should think his article would have been devoted, not to acupuncture, but rather to telling the world how the Chinese have accomplished the "virtual abolition of hunger, disease, floods, and drought." The news is so exciting that I should think the whole March issue of NATURAL HISTORY might have been devoted to it.

ROBERT S. ZOLLNER
Andover, Massachusetts

A Choice

"The Elephant Man," by Sir Frederick Treves (March, 1972) is a tribute to the writer, a famous medical doctor, and also to the unfortunate subject of the article, who obviously rose above the behavior most of us might have presented under similar circumstances.

As a child I remember that each time a carnival came to my little town, one of the first dimes I spent would be for admission to a tent where several microcephalics (grotesquely advertised as "pinheads") were on display. Usually they wore an austere gown or simple dress, had their hair done up in Kewpie-doll fashion to accent the diminutive proportions of their crania, and standing eight or ten feet apart, tossed a five-inch hollow rubber ball back and forth, their only performance. I can only excuse my participation in such an otherwise inexcusable affair as the ignorance and curiosity of childhood.

Thank God such displays of unfortunate human beings are rarely seen today. While the typical "fat lady" and the "rubber man" may make their own decisions, microcephalics and other mentally retarded humans have no such choice.

LYLE G. BOUNOUS
Professor of Education
Pan American University

To Convince Society

The article by Kenneth E. F. Watt ("Man's Efficient Rush Toward Deadly Dullness," February, 1972) is one of the best articles I have read in your magazine. Well done.

All that remains is to convince society that Watt and others are correct, and we may yet save ourselves.

ROBIN LEECH
Entomology Research Institute
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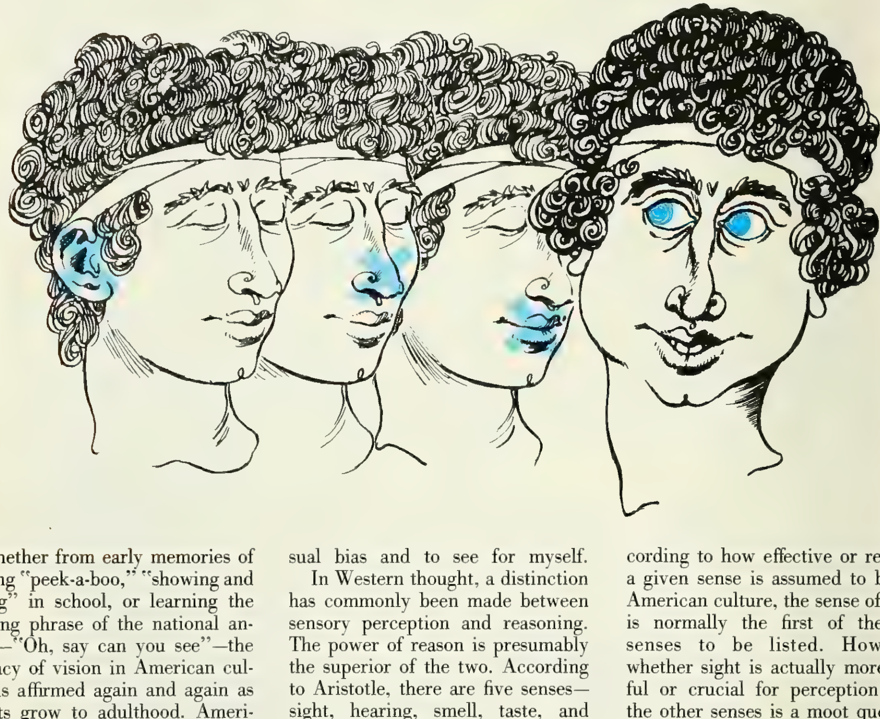
Seeing Is Believing

A brief look at visual terms used in American speech illustrates just how much culture affects perception



Whether from early memories of playing "peek-a-boo," "showing and telling" in school, or learning the opening phrase of the national anthem—"Oh, say can you see"—the primacy of vision in American culture is affirmed again and again as infants grow to adulthood. Americans are conditioned from childhood to believe that "what you see is what you get."

There is more to such a phenomenon than immediately meets the eye. That Americans rely more on vision than on other senses doesn't mean that they are aware of it. Nor does it mean that it is a peculiarly American trait. People everywhere rely on their senses to perceive their world and order their experiences, but since my data are derived from American folk speech, I cannot speak about others. In any case, because I have been taught to mistrust hearsay, I have decided to take a look at the evidence for a visual bias and to see for myself.

In Western thought, a distinction has commonly been made between sensory perception and reasoning. The power of reason is presumably the superior of the two. According to Aristotle, there are five senses—sight, hearing, smell, taste, and touch—which provide data generally deemed less trustworthy or, at least, frequently illusory, compared to the information that is provided by the faculties of rational thought. Subjective versus objective and body versus mind are other expressions of this distinction between the sensory and the rational. If we assume, however, that reasoning cannot take place without some reference to metaphor, then it is certainly possible that much American logic and reasoning is closely tied to metaphor in general and to visual metaphor in particular.

The allegedly inferior sensory experiences seem to be ranked according to how effective or reliable a given sense is assumed to be. In American culture, the sense of sight is normally the first of the five senses to be listed. However, whether sight is actually more useful or crucial for perception than the other senses is a moot question and, in fact, does not require an answer to show that a cultural bias for the sense of sight really exists. In the present context, it is not the literal meaning of sight that is important, but the metaphorical. I believe that, metaphorically speaking, Americans tend to *see* the world around them, rather than hear, feel, smell, or taste it. It may be no accident that Americans *observe* laws and holidays.

American speech provides persuasive evidence to support the notion that "vision" is used as a metaphor for "understanding." Consider, for example, the classic punning proverb, " 'I see,' said the blind man,

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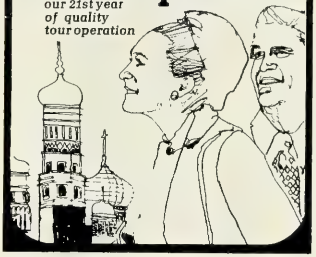


as he picked up his hammer and saw." The oppositional structure in this text is produced by the juxtaposition of sight and blindness. Here is a clear distinction between literal and metaphorical seeing. Literally a blind man cannot see, but figuratively he certainly can.

Americans consistently speak of "seeing" the point of an argument when, in fact, an argument is not really seen but comprehended. Intellectual positions, or "perspectives," are frequently referred to as points of *view*. When articulated, they may be introduced by such formulas as, "As I see it" or "It all depends on how you look at it."

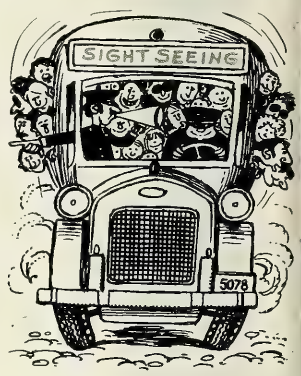
American culture is pronouncedly concerned with empiricism, and this empiricism is explicitly visual. "Seeing is believing" and "I'm from Missouri" (which means "you've got to show me") are indications of the emphasis on seeing something for oneself and the tendency to distrust anyone else's report of a given event. "I saw it with my own (two) eyes" is a common authenticating formula, as is the invitation to "see for yourself."

Without sight, there may be disbelief or lack of faith: "I'll believe it when I see it," "That I've got to see," or "I can't picture that." Even though the reliability of vision may be questioned—"There's more to this than meets the eye"—in general, people tend to believe what they see. Thus, when something is really out of the ordinary, we say, "I couldn't believe my eyes." Something that is incredible or unbelievable is termed "out of sight," a phrase dating from before the end of the nineteenth century.

Imagination is sometimes called "the mind's eye," but why should the mind have an eye? Probably for the same reason that patients want doctors "to see them." Telephone conversations or other purely oral–aural channels are not considered entirely satisfactory. Actually, the patient is probably relieved by *his* seeing the doctor. Seeing the doctor, in turn, is part of the widespread cultural insistence upon interviews. Literally, the word *interview* refers to A seeing B and B seeing A.

Consider the nature of American tourist philosophy—sightseeing. To "see the sights" is a common goal of tourists, a goal also reflected in the mania for snapping pictures as permanent records of what was seen. Typical travel boasting consists of inflicting an evening of slide viewing on unwary friends so that they may see what their hosts saw.

This is surely a strange way of defining tourism. Visiting a foreign locale certainly involves all of the sensory apparatus. There are exotic smells and tastes, and the opportunity to savor new foods and experience the "feel" of a foreign setting



is as important in understanding a country and its people as seeing them. One reason Americans frequently fail to enjoy touring as much as they might may be their almost compulsive tendency to see as many sights as possible. The seeing of many sights is, of course, consistent with a tendency to quantify living, and, specifically, with the desire to get one's money's worth.

When shopping, whether in foreign countries or at home, Americans are reluctant to buy anything "sight unseen." They prefer "to look something over," "to walk into something with their eyes open." A thorough inspection theoretically allows one to "see through" a pretense or fake. And obviously, a product can only "catch a person's eye" if he sees it.

Public "images," too, are part of the visual pattern. But why, after all, should a person have to be depicted in a term such as image? Even though looks may be deceiving ("Never judge a book by its cover"), it seems clear that packaging that appeals to visual esthetics is equally effective whether one is hawking cigarettes or automobiles or selling political candidates.

The reduction of persons or events to purely visual terms is also evident in the use of the popular slang phrase for a detective: "private eye." By the same token, sleep is commonly referred to as "shut-eye," which obviously singles out only one aspect of the dormant state. Furthermore, this suggestion that sleep is shut-eye also implies that the waking state is marked chiefly by having one's eyes open.

As I collected examples of folk speech, I soon found that comparison of vision with the other senses reaffirmed the superiority of sight. That a "seer" can make predictions by gazing into a crystal ball, for example, suggests that vision is more effective than the other senses in fore*seeing* future events.

The same bias in favor of the visual is found in American greeting and leave-taking formulas. Examples include: "See you around," "I'll be seeing you," or "I haven't seen so-and-so in ages." Greetings may also be couched in visual terms. "It's good to see you," Americans say, rather than, "It's good to hear, smell, or feel you."

There seem to be relatively few complimentary references to hearers, smellers, talkers, and touchers. "Look, but don't touch" hints at a delight in gawking (girl-watching), and possibly at a cultural distaste for body contact. Someone who is "touchy" is not pleasant to have around. A "soft touch," which sounds as if it should have a positive connotation, is a slang term for a dupe or easy mark.

One of the most interesting pieces of evidence supporting the notion of visual superiority over the other senses is that the original version of "Seeing's believing" was presumably "Seeing's believing, but feeling's the truth." That most Americans have dropped the second portion of the proverb does not seem to be an accident. Rather, it reflects a definite penchant for the visual in contrast to the tactual. Originally, the proverb denigrated "seeing" in favor of "feeling."

Comparisons between the visual and the aural are the most common, however, with hearing considered second best. Consider "Believe nothing of what you hear and only half of what you see." Although caution is urged against believing everything one sees, seeing is surely

depicted as being more reliable and trustworthy than hearing. Compare the following two statements: "I hear that X has just moved to Miami," and "I see that X has just moved to Miami." The first statement is possibly true, possibly not true: there is an element of doubt. The second, in contrast, seems to be a statement of fact.

Other instances are found in legal parlance. Although judges hear cases, there is no doubt that *hearsay,* that is, aural–oral, evidence is not in the same league as that offered by an eyewitness. Actually, the word *witness* indicates that the person was physically present during an event and saw with his own eyes the activities in question. If so, then the term *eyewitness* is redundant. Strangely enough, at *hearings* there is an insistence that *hearsay* evidence be rejected and that only *eyewitness* testimony be accepted. On the other hand, it is interesting to recall that Justice is depicted as being blind. Justice cannot see and presumably blindness guarantees fairness. But of course, sometimes even an innocent man may be guilty "in the eyes of the law."

The eye is also more powerful than the ear insofar as it is regarded as an active rather than a passive agent. The eye looks, peers, or gazes. There is seductive power in the eye, as in "giving a girl the eye," and the malevolent power of the eye is manifested in "the evil eye." The ear, by contrast, is a passive receptacle. There is little evidence of evil ears. Remember also that "big brother is watching you," not listening to you, although bugging rooms with microphones makes listening more likely than watching. Note also that voyeurs, such as Peeping Toms, are considered to be worse than eavesdroppers. The active versus passive with respect to seeing and hearing may also be implied by the connotative differences between "spectators" and "audience."

Marshall McLuhan and his followers have suggested that the oral–aural channels of preliterate, or rather, nonliterate man may be enjoying a renaissance. According to this view, as man becomes literate, written language—which must be seen to be read—takes priority over the oral. Recently, however, radio and television have created postliterate man, whose world is once more primarily oral–aural. Many Americans learn the news of the day by hearing it on the radio rather than by reading it in newspapers. Even on television, the argument says, the news is mainly told, not shown. Then, too, telephone conversations are replacing letter writing more and more.

One can contend, however, that television has replaced radio, and thus the visual still supersedes the purely aural. Americans still prefer to get agreements in writing rather than to trust a gentleman's handshake (a tactile sign) or take someone's word or say-so (oral sign) for a contract. Once an agreement is down in black and white, Americans watch out for, and read, the small print, with an "eye" toward avoiding an unfavorable set of conditions.

If Americans do have a deep-seated penchant for the visual sense, as I have tried to suggest by examining American folk speech, the question of what it means remains to be answered. It is not just a matter of being able to see more clearly why Americans tend to look for men of vision to lead them. Much more important is the influence of folk metaphors on scientific thought. American science is not culture-free, no matter how devoutly American scientists wish that it were or think that it is.

As an anthropologist, I am struck by the fact that American anthropologists insist upon being participant observers (not voyeurs!) when they go into the field so as to gain insight into the world-views of other cultures. Why "insight"? Do all examples of problem solving by insight actually involve visual perception? And why world-view?

Anthropologists do not always agree whether man is active or passive with regard to world-view. Bronislaw Malinowski, for example, tended to consider man passive: he depicted man as being molded by the impress of a culturally patterned, cookie cutter kind of world-view, which imposed its structure upon human minds. "What interests me really in the study of the native," Malinowski said, "is his outlook on things, his *Weltanschauung.* Every human culture gives its members a definite vision

Continued on page 86

A Resurgence o

Because the virus spreads in wildlife, a rabies epidemic continues to grow throughout the world

On Christmas Day, 1971, Melvin Barton of Trail Town, Florida, went deer hunting; he took with him into the Everglades swamps his favorite hound, a mixed, predominately beagle dog named Drum. It wasn't long before the dog met and fought with one of the many raccoons of the south Florida region. As Barton grabbed the raccoon by the back of the neck and tail to separate the fighting animals, he thought briefly that the raccoon seemed sluggish. It even fell once from the low tree limb where Barton had placed it.

Assuming that the raccoon was only feeling the effects of the encounter with the hound, Barton ignored the animal and looked to his dog. Drum had only a few scratches and bite marks on an ear and over one eye. Since the dog seemed anxious to continue hunting, Barton quickly forgot the incident. On February 29, the dog showed the first signs of rabies.

When the dog and the raccoon fought, the two natural cycles of rabies came together. One cycle, within wildlife, is self-propagating. The second cycle, that in man and his domestic animals, functions when it is fed by the wildlife cycle. Rabies, which remains alive in wild animals, occasionally erupts into epidemics that envelop man. In much of the world, both wildlife and man are now experiencing such an epidemic.

More than two months after the fight, Drum lost his appetite and became restless. He whined and cried and seemed to crave attention. During the next two days the dog became untrustworthy, often growling at other dogs and people that approached his pen. On the third evening he chewed through the ¾-inch plywood floor of his pen and escaped into the small Everglades community.

At this time he was viciously aggressive. As he roamed, his facial expression was one of alertness and anxiety. Any noise invited angry growls, and he seemed to have an instinctive desire to attack moving objects. Because the virus had affected the neuromuscular function of the throat, he could not swallow, and saliva, built up from his excitation and exertion, accumulated on his jowls and chin, dropping to the ground as foam.

For almost nine years Drum had been a faithful companion and one of the most successful hounds in Collier County; now he was a mad dog, threatening every person in the area.

More than seventy days after the raccoon bit Drum, the first clinical signs of rabies appeared. Most human and animal diseases spread rapidly—by extension from infected tissue to nearby healthy tissue, or within the circulatory system, or by both methods. A minor skin infection, for example, can progress from the finger to the hand and to the arm and axilla in a few days. Rabies virus, however, travels slowly up the nerves from the bite to the brain. In bites involving heavy exposure, the virus travels approximately three millimeters per hour, and it can first be detected in the part of the brain that controls the area bitten.

Once the virus reaches the brain, it both causes encephalitis and begins to travel down nerves to the salivary glands. In dogs and man signs of aggressiveness and ferociousness develop at about the same time that the virus reaches the salivary glands. When a rabies-infected animal (or human) bites a susceptible individual, virus in the saliva enters the tissues of the victim, and, thus, the virus successfully renews its cycle

As the rabid dog moved along Florida's Route 41, the only paved road in Trail Town, the virus had essentially completed its course in him. In essence Drum was dead existing now only to serve the virus All mammals are susceptible to rabies; cases of the disease have been documented in nearly all but marine mammals. On the evening of March 2, however, a Trail Town resident named Larry Strickland became particularly vulnerable. It was then that Strickland saw the dog disappear into an auto junkyard. He recognized Drum, knew he was a valuable hunting dog, and worried that Drum might be hit by a car on Route 41, Strickland decided to capture the animal and tell Barton.

In a paradox typical of the erratic behavior of rabid animals, the dog allowed himself to be caught and tied by a rope around his neck to a post. As Strickland walked away, the dog frenetically chewed through the rope and attacked him, leaving several teeth punctures in his calf. Again the dog allowed Strickland to capture and tie him to the post; this time with a metal chain.

When Strickland returned to the junkyard with Barton, both men watched the dog and quickly realized that he was violently disturbed. They carefully loaded him into a car and drove 40 miles into Miami to a veterinary hospital. At 11:30 P.M., as an attendant, David Smart, helped unload the dog, some saliva dripped on to a fresh scratch on his hand. At 1:00 A.M. on March 3 the veterinarian in charge examined the animal and diagnosed rabies. The dog, which would have died within a few days, was put to death that morning. But the rabies virus had achieved its goal. It may have transferred from Drum to the sixty other Trail Town dogs or to wild animals that the dog might have bitten after he had escaped. The virus had definitely found two potential hosts,

Rabies by Norman Frank

Larry Strickland and David Smart.

The events that led to the infection of Strickland and Smart are typical of man's worldwide rabies problem. The rabies virus that exists within wildlife was transferred to man through his domestic animal. Although Trail Town is situated in an area of endemic raccoon rabies, none of its inhabitants were in immediate danger until the dog contracted the disease. The majority of human rabies exposures come from contact with domestic animals. Although all domestic mammals are susceptible, including cattle, sheep, swine, horses, goats, and cats, it is the dog that most often carries the disease to man.

Jonathan Swift, speaking of man's unique relationship with the dog, once said that "we are so fond of one another because our ailments are the same." This is particularly true in the case of rabies. The disease has been recognized as afflicting both man and dog since antiquity, when that period of summer heralded by the rising of the Dog Star, Sirius, was referred to as "the time of dog days." During these days, the people of ancient civilization recorded that dogs, ordinarily friendly and docile, would become aggressive and dangerous. They would roam the streets and, after a short period of maniacal behavior, collapse and die. Sometimes people who came into contact with these animals would subsequently follow the same mad route to death. Even today the expression *dog days* denotes an extremely hot and uncomfortable period.

In the early 1880s the French scientist Louis Pasteur, working with dog rabies, completed one of the most significant studies in the history of investigative science. He found that if rabies virus recovered from mad dogs, called "street" virus, was passed through one rabbit after another, it eventually would not cause the disease when injected into healthy dogs. Yet the virus, now called "fixed," was suf-

Bitten by a coon hound, Larry Strickland began treatment for rabies early in March. He will not be out of danger until May 31.

When Rabies Strikes

When you are bitten or scratched by a suspected rabid animal, the most important action you can take is vigorous irrigation, with water, of the wound. The importance of quickly washing the virus-laden saliva from the injury cannot be overemphasized. Positive diagnosis of rabies can only be made by laboratory tests on the animal's brain. If exposure to rabies is confirmed, medical treatment should then proceed, with the administration of a massive injection of equine-origin hyperimmune serum and then a 23-dose series of duck embryo vaccine.

It is important that treatment be instituted immediately, before much of the rabies virus can become bound to the nerve. With the older vaccine there was a danger of permanent neurologic damage from the treatment, but with the duck embryo vaccine this is no longer a factor. There is, however, a possibility of allergic reaction, especially to horse serum. A physician must decide which is the greater risk, rabies or a severe allergic reaction to the treatment.

The National Center for Disease Control advises doctors and public health officials in the United States to weigh the following factors when considering treatment of a suspected rabies case if the animal cannot be laboratory examined: Carnivorous animals (especially skunks, foxes, coyotes, raccoons, dogs, and cats) and bats are more likely to be infective than other animals. Bites of rodents, including squirrels, chipmunks, rats, and mice, seldom, if ever, call for rabies treatment.

An unprovoked attack is more likely to indicate that the animal is rabid. Bites during attempts to feed or handle an apparently healthy animal should generally be regarded as provoked.

Because the likelihood that rabies will result from a bite varies with the extent and location of the wound, two categories of exposure are considered: (1) Severe, in which there are multiple or deep puncture wounds, or any bites on the head, face, neck, hands, or fingers and (2) mild, in which there are scratches, lacerations, or single bites on areas of the body other than the head, face, neck, hands, or fingers. Open wounds, such as abrasions, suspected of being contaminated with saliva also belong in this category.

An adult animal immunized properly with one or more doses of rabies vaccine has only a minimal chance of developing rabies and transmitting the virus.

The safety of the duck embryo vaccine has made it reasonable to offer pre-exposure immunization to persons in high risk groups: veterinarians, animal handlers, certain laboratory workers. Others whose vocational or avocational pursuits result in frequent contact with dogs, cats, foxes, skunks, or bats should also consider pre-exposure prophylaxis. This vaccination is not completely effective, but it greatly reduces the risk of rabies infection and simplifies any post-exposure treatment.

Rabies control in domestic animals is easy and generally well accepted in the United States. All dogs and cats should be vaccinated with an approved modified live vaccine by the time they are six months old. Boosters every two to three years are sufficient to protect the animal.

ficiently similar to the street virus to induce antibody production in the healthy dog. Thus Pasteur could administer fixed rabies to a dog, wait several weeks for the animal to develop natural antirabies antibodies, and then inject the street virus. The dog resisted rabies and remained healthy.

Pasteur's classical rabies experiments have been studied by generations of medical students and scientists. Our current polio, rubella, smallpox, measles, and other vaccinations are all a direct extension of Pasteur's work.

For many years it has been thought that rabies could be eliminated by vaccination of dogs. Countries that practiced dog rabies control had dramatically fewer cases of rabies than countries that did not. For instance, during the first six months of 1971, only one person died of rabies north of the Rio Grande, while at least 131 died of rabies in the countries to the south. The United States and Canada both have dog rabies programs, while in the rest of the Americas the dog-control problem is vast, with nonvaccinated dogs presenting the greatest risk.

In India, where there are five million unvaccinated dogs, as many as one out of every five hundred patients admitted to hospitals dies of rabies. An epidemiological survey of rabies cases in Delhi showed that most of the victims had been bitten by stray dogs. Each year, more than 100,000 people receive antirabies treatment at the Pasteur Institute at Coonoor and at the treatment centers in Delhi. There are 1,564 antirabies treatment centers in India.

In the Philippines about 25,000 dogs and between 200 and 300 people died from rabies in 1970; all the human cases resulted from exposure to rabid dogs. Philippine health officials maintain that rabies control could be easily accomplished, pointing to the city of Manila where dog rabies has not been reported for six years following a successful dog vaccination program.

The control of human rabies by the control of dog rabies is graphically illustrated in El Paso, Texas, where rabies had been prevalent since 1835. For the period 1953 to 1967, animal rabies occurred at the rate of almost fifty cases per year, 88 percent in dogs. Between 1965 and 1968 efforts were made to enforce vaccination and registration of all dogs, to control stray animal populations, to investigate all animal bites and exposures, and to enforce the "leash law" for dogs. In 1968 there were only eleven cases of animal rabies in El Paso, none of which were in dogs. Two years earlier almost 1,000 people received antirabies treatment; by 1968, there were fewer than 300. Unfortunately, the relatively simple program of dog vaccination and control is not an ultimate solution to the rabies problem, because of the other, almost separate cycle of the disease in wildlife.

That the flare-up of rabies at Trail Town had its roots in the wild raccoon population is not surpris-

In the Everglades, a hound corners a raccoon. The rise in raccoon rabies makes such contacts dangerous for both dog and man.

ing. Florida and south Georgia account for more than 90 percent of all raccoon rabies reported in the United States.

The existence of rabies virus in raccoons was first reported in Florida in 1947, from Brevard County, in the center of the Atlantic coastal region. By the late 1950s raccoon rabies covered most of peninsular Florida. Twenty-six cases of raccoon rabies were reported from north Florida in 1961. The next year the disease advanced into Georgia. The epidemic moved northward, shunning the Atlantic and Gulf coasts, and by the end of the decade extended across central Georgia north to Macon. In the fall of 1970, rabid raccoons were reported in the Florida panhandle, indicating both a westward spread of the disease and an end of the virus-free status of the upper Gulf Coast.

Serum samples collected from wild raccoons in Florida during this period revealed an infection rate of 2 to 20 percent. Serum samples col-

lected from Illinois, Texas, and South Carolina during the same time, were either completely negative or showed a low rate of infection. This substantiated the presence of a rabies epidemic in the Florida–Georgia region.

In January, 1969, the number of rabid raccoons suddenly increased on the island of Long Boat Key in west Florida. The island, about 40 square miles in area, had a seasonal human population of between 4,000 and 7,000. Most of the key was commercially developed. In six months, 51 raccoons delivered to the state laboratory were positive for rabies. Raccoons were live-trapped, and about 10 percent of these were positive. The raccoon population was approximately 50 to 80 per square mile. This means that some areas had eight or more rabid animals per square mile.

The epidemic seriously threatened the health of the community, but control of the disease was difficult because of a social response that public health officials had not anticipated. Karl D. Kappus of the Center for Disease Control described the situation:

"The raccoon population was maintained at a level far above the 'natural' carrying capacity of the island by easy access to food and the

Continued on page 80

Women's Fib

Promise men anything, but give them peace

"Anatomy is not destiny," say the leaders of women's liberation. They mean that sexual differences need not set limits to the quality of an individual's life. Everyone recognizes, of course, that the possession of ovaries rather than testicles leads to different kinds of experiences. But what the theoreticians of the sexual revolution are getting at is that ovaries, testicles, and other sex-linked accessories are irrelevant when it comes to the question of how economic and political privileges and obligations ought to be distributed within human groups. They are saying that, aside from childbearing, the assignment of social roles results from social convention, or culture, rather than from biological attributes. And they are correct when they insist that no biological imperative assigns American women the dominant role in child rearing, makes them domestic drudges, and forces them to step aside for males at high managerial and political levels.

Culture is the gatekeeper of sexual destiny. But the realization that sexual roles are cultural is not sufficient reason to conclude that they are arbitrary and undetermined. It does not mean that sex roles are whimsical, unpredictable, and unresponsive to physical and biological conditions. Subordination of females happens to occur with remarkable persistence in a great variety of cultures. When a human relationship occurs with great frequency across space and time, we must suppose that there are determinate reasons for it. Culture itself is a form of "destiny."

Leaders of women's liberation concede that female subordination has been characteristic of societies on all levels of technological development. Some, like Kate Millet, even exaggerate the uniformity of sex roles in order to anathematize so-called patriarchal society. This social system is supposed to be equally well exemplified in hunting and gathering bands, village farmers, pastoralists, ancient states, and modern industrial nations. The sexual hierarchy does not exhibit precisely the same shape and substance in each of these different settings. Each social system presents novel distributions of power and authority, and even in our own society our knowledge of sex roles is extremely tenuous.

Nevertheless, there are four general sets of facts that prove the existence of a widespread cultural bias against females. First, with respect to authority and power in domestic relations, there is the prevalence of polygyny (one man, plural wives) and the corresponding rarity of polyandry (one woman, plural husbands). Second, with respect to domestic ideologies and economic organization, descent and inheritance are usually in the male line, and wives usually leave their own families to reside with their husbands. Third, with respect to political economy, there is the preponderance of male gerontocracies and patriarchies as opposed to the absolute nonexistence of a single ethnographically reliable instance of matriarchy. And finally, there is demographic selection against females through female infanticide. In many tribal societies, this results in an unbalanced sex ratio, as reported in my column last March.

The bias against human females constitutes a remarkable paradox. Women, after all, are biologically more valuable than men, and if biology were in fact "destiny," the bias would be against men. Women can do everything that men can do, although with perhaps some slight loss of efficiency where brute strength is required. They can hunt, they can (and do) carry heavy burdens, they can (and do) work in the fields. Men can neither bear children nor (without advanced technology) provide them with vital nutrients during infancy. The only respect in which men are biologically indispensable for the survival and well being of human populations is as genitors. But for that role, one male will suffice for many women. If biology were destiny, we

Photographed in the Highlands outside Dufftown, Scotland.

This wee beastie knew the secret of Grant's 8 Scotch before the Grants did.

In 1885 Major William Grant was looking for a special kind of place to build his new Scotch distillery, with spring water clearer and fresher than anyone else's.

Then someone told him about Robbie Dubh's spring, in the village of Dufftown, where the rugged Highland cattle grazed. For years they had it all to themselves.

The water was perfect. So the Major bought the land, moved the Highland cattle to a new pasture of their own and soon was making the best Scotch whisky you could buy.

Today the icy fresh water of Robbie Dubh's spring is still part of Grant's 8 Scotch. It still helps create the smooth, light, balanced flavor that's mellowed to perfection for eight full years.

And Major Grant's great-grandchildren still give this special blend of Highland and other fine whiskies the kind of personal care and attention that only a family-owned and family-operated business can offer.

That's the secret of Grant's 8 Scotch. And you share it every time you open a bottle.

Grant's® 8 Scotch: share our family secret.

Blended Scotch Whisky 86 Proof, ©1972 William Grant & Sons, Inc., N.Y. Importers. Bottled in Scotland.

would expect polyandry to be more common than polygyny, male infanticide to be more common than female infanticide, and matriarchy more common than patriarchy.

The women who favor the greatest possible scope for revolutionary cultural innovations in sex roles are now denying the existence of deterministic natural and cultural processes that might account for female subordination. Millet, for example, insists that since patriarchy is a social and political form we must "look outside nature for its causes."

But what is there to look to outside of nature? Nothing but an irrational—and ultimately evil and inscrutable—conspiracy on the part of males to humble and exploit their female companions. The only effective answer to such a conspiracy is deemed to be a counterconspiracy, one in which females, united by a consciousness of their common degradation and biological superiority, carry out a sexually organized political revolution against the male oppressors. I call this "women's fib." Much of the ritualized animosity toward males that has become the hallmark of the contemporary liberated woman derives from this analytical error.

There has not yet been a definitive scientific answer to the question of why female subordination is so prevalent. In recent years, however, ecologically oriented research has led to new insights into the relationship between sex roles and warfare. One hypothesis that emerges from this research is that female infanticide is a mechanism of population control and that warfare among tribal peoples is a consequence of female infanticide.

Whatever the cause, war and female infanticide seem to have been endemic and to have functioned to control population among many band- and village-organized societies. Among state-organized peoples, warfare increased in fury and scope proportionate to the increments in capital and labor that could be expropriated or exploited after military conquest. In all forms of warfare practiced to date, males have been the effective primary combatants.

Some women insist that the secondary role played by female combatants is itself a matter of male conspiracy. But this ignores the seriousness of war and the extent of the slaughter for which it has been responsible. Males have been, and continue to be, trained as the primary combatants because in the deadly immediacy of the battlefield, the physical differences between the sexes, however slight or potentially modifiable, loom as the difference between life and death for entire populations and social systems.

One of the main weaknesses of the male conspiracy theory is that the domestic subordination of women places them in a powerful strategic position with respect to the formation of the male personality. Women control the nursery and the early childhood conditioning of both sexes. We know from psychoanalytic experience that women do not lack the opportunity to block the development of aggressiveness before the adult males themselves take over the training of boys. The adaptiveness of the sexual hierarchy results in women themselves inculcating the "masculinity" of which they are the victims. This fact would be inexplicable if female subordination were merely an arbitrary, nonadaptive, meaningless expression of male vanity.

For primitive societies, the basis of female subordination is the absence of technological solutions to the military problems associated with conception, menstruation, pregnancy, and lactation. For industrial societies we must look elsewhere. Perhaps it has been found that higher levels of controlled aggressiveness and brutality can be attained in males when the achievement of masculinity is linked to the subordination of females. To put it bluntly, the institutionalized privilege of being able to exploit women is the reward that modern militaristic societies give to males who serve as cannon fodder.

My analysis of the relationship between sexual hierarchy and war leads to a practical suggestion. The strategy of sexual politics requires that the superordinate males who are threatened by the sexual revolution be promised something in exchange for their lost privileges. What could be better than to promise them peace?

Marvin Harris teaches anthropology at Columbia University.

To do many different jobs NASA chose many different cameras. Hasselblad.

500 C

In 1962 NASA chose Hasselblad to be used by the Astronauts on manned spaceflights.

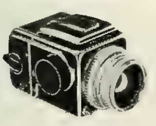
The first Hasselblad to go up was the 500C, aboard the Mercury Spacecraft Sigma 7. The camera has an 80mm Zeiss Planar f2.8 lens and 12-exposure magazine. All components are interchangeable.

The famous first walk in space by Astronaut Edward White, aboard Gemini 4, was recorded by Command Pilot James McDivitt, using a 500C.

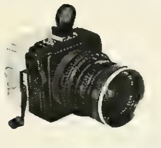
NASA chose Hasselblad for the space program because of its legendary reliability, quality of results, ease of operation (Astronauts are not professional photographers) and scope as a photographic system. These same characteristics have made Hasselblad the choice of discriminating photographers on earth.

A Hasselblad camera is what you make of it. Snap on a super wide angle Zeiss Distagon 40mm lens, a 24-exposure magazine and an eye-level prism finder, and it becomes one thing. Switch to a Zeiss Tele-Tessar 500mm lens, a 70-exposure magazine, a pistol grip—and it becomes something else again.

That's why photographers of all kinds—commercial, advertising, news, scientific, industrial, amateur—all satisfy their diverse photographic needs within the Hasselblad System.



500 C/M



Super Wide C

For four years and eight manned spaceflights, the 500C was *the* Hasselblad space camera.

Then in 1966, a second Hasselblad was added. The wide angle Hasselblad SWC, with its 38mm Zeiss Biogon lens.

It made its first flight aboard Gemini 9, where Astronaut Eugene Cernan used it on his 2 hour space walk. During that walk the camera operated flawlessly in total vacuum.

An exciting glimpse of life inside the capsule was also made possible by the SWC, because of its sweeping 90-degree angle of view and great depth of field.

On earth the SWC is used by industrial, architectural, landscape and amateur photographers. The SWC allows them to work indoors and out, at extremely close quarters, with extraordinary sharpness from corner to corner and incredible depth of field (from 26 inches to infinity at f22).

News and sports photographers make interesting use of the unique features of the SWC by presetting it, snapping on 70-exposure film magazine, then using it to take grab shots when there isn't time to focus.

The versatility of the SWC is extended by the use of interchangeable film magazines and other components of the Hasselblad System.

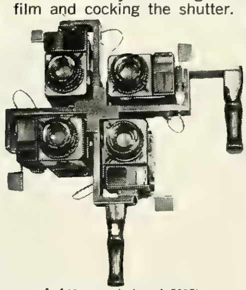
Super Wide C

500 EL

Two and a half years later, in December 1968, a third Hasselblad joined the space program—the electrically-driven 500EL. The event was the flight of Apollo 8. Two 500ELs went along—one with an 80mm lens, the other with a Zeiss Sonnar 250mm lens—plus 7 interchangeable 70mm magazines.

This was the first time that men journeyed from earth to orbit another world. The photographs from this voyage were essential in planning the forthcoming lunar landing.

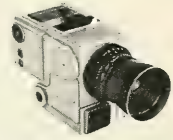
The Hasselblad 500EL allowed more photographs to be taken with less effort, because no film winding was necessary. After each exposure the 500EL automatically readies itself for the next shot by advancing the film and cocking the shutter.



A 4-camera cluster of 500ELs used for scientific photography in space

This Hasselblad is the only electrically-driven 2¼" camera on earth. Because of its automatic features, it can be sucessfully operated from a distance, freeing the photographer from the camera and allowing him to work more with his subject. That's part of the reason why the Hasselblad 500EL/M has won the esteem of advertising and publicity photographers, as well as sports, wildlife, industrial and scientific photographers.

500 EL/M



500 EL Data Camera

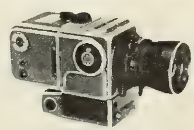
But the first camera to be used on the moon wasn't the Hasselblad 500C, or the SWC, or even the 500EL. It was a fourth Hasselblad—the 500EL Data Camera, with Reseau plate and Zeiss Biogon 60mm f5.6 lens. A photogrammetric camera, whose tiny cross-shaped index marks appear on the negative, making it possible to measure distances and heights with great accuracy.

When Astronaut Neil Armstrong took man's first walk on the moon, on July 20, 1969, the Hasselblad 500EL Data Camera was there with him, attached to his chestpack.

The 500EL Data Camera proved so valuable that an earth version—the MK70—was developed and is the newest addition to the System.

The MK70 fills a need for a small, easy-to-handle photogrammetric camera capable of producing exceptional results. The MK70 is the ideal photographic tool for use in applied engineering and construction work, as well as for mapping, architectural, industrial and medical photography.

For a free copy of the 48-page Hasselblad catalog, describing all the different cameras and accessories of the Hasselblad System, write Paillard Incorporated, 1900 Lower Road, Linden, N. J. 07036. Other products: Bolex movie equipment, Hermes typewriters and figuring machines.



MK70

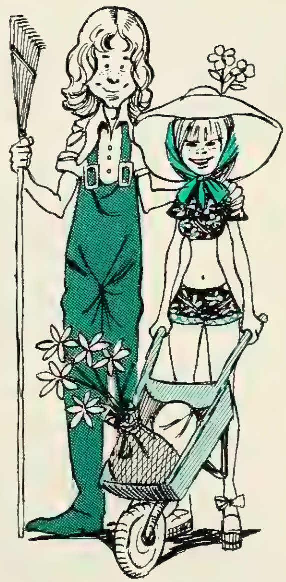
It takes more than one camera to make a system.

HASSELBLAD®

by Arthur W. Galston

The Organic Gardener and Anti-intellectualism

Several years ago, in response to the then strong student pressures for "relevance" in education and moved by a desire to consider certain social problems in the framework of the newer knowledge of biology, several colleagues and I initiated a course entitled "Biology and Human Affairs." Designed for nonmajors and actually for nonscientists (it inevitably became known as "Biology for Poets"), the course has attracted relatively large numbers of students and has met with moderate success in its effort to provide some biological background against which one can consider such topics as population growth, pollution, genetics and intelligence, organ transplantation, biological engineering, and chemical and biological warfare. Teaching such a course is a challenge because of the great diversity of student backgrounds in biology (How much basic science should I teach?) and because of the inadequate grounding in social science of most biologists, compared with the occasionally great sophistication of some students (Am I out of my depth?). These difficulties have resulted in a constant modification of the course, both in subject matter and approach, a situation that is likely to continue for some years.



Interacting with the students in informal discussions has made several instructors in the course aware of the extent to which many students have become disillusioned with science—as a method of arriving at an understanding of man and the universe in which he lives and as a means of improving the quality of life. To many of the "poets" in the course, scientists are otherworldly people, content to fiddle in their laboratories while the world—for which they are at least partly responsible—burns in napalm, decays into pollution, and becomes dehumanized into mechanical, computerized, assembly-line work routines.

The scientist is also held responsible for the antisocial uses to which many of his discoveries are put by the military (bombs, chemical and biological weapons, flamethrowers, automated battlefields), by government (electronic "bugging" devices, computerized data banks for political dissidents), and industry (shoddy mass-produced automobiles, chemical products that pollute the environment, useless and expensive gadgetry). Many students seem unwilling to agree that the findings of the scientist are ethically neutral, and that it is society that must determine whether they shall be used for good or evil. Because of his special insight and knowledge, the scientist is expected to give guidance to the decision-making agencies of government and business (which frequently do not respect his testimony) and to maintain constant surveillance over the new technology his research discoveries have spawned. Since, with relatively minor exceptions, scientists have not performed this watchdog role adequately, both society in general and students in particular have recently given much less approval to the aspirations and accomplishments of science than heretofore. In addition, some students have reacted with cynical disbelief to some of the data of science, which they would not have questioned several years ago. Let me illustrate with one case history.

As a reaction to the recent exposés concerning the deleterious effects of various pesticides on animal life and the ecosystem, the possible damage to babies from inordinately high quantities of nitrates in their foodstuffs—a result of the application of high quantities of chem-

ical fertilizers—and the known toxic effects of certain common chemicals used as food preservatives, some people, including many students, have become devotees of "organic gardening." Produce grown by organic gardeners is ostensibly never subjected to potentially toxic pesticidal sprays, is fertilized only by manure, leaf mold, or other organic materials, and is never artificially preserved by chemicals. Materials so produced are often more expensive than the usual commercially available foods and frequently must be purchased in special stores.

In the course of my lectures on botany, I had occasion to point out that the green plant is a complete autotroph for organic materials, that is, given only carbon dioxide from air, sunlight, and water, plus inorganic minerals from the soil, it is capable of synthesizing the thousands of organic compounds out of which it is constructed. Under favorable soil conditions, it has absolutely no need for any external sources of organic compounds; and the harvest produced from crops supplied with purely inorganic fertilizers will be just as rich in vitamins, amino acids, and other key nutritional requirements for man as one produced from heavily manured crops. This has been demonstrated many times, not only by analyzing for such components in the laboratory, but also by feeding test animals with both kinds of products. In the absence of evidence to the contrary, almost all scientists would conclude that there is no demonstrable difference, either chemical or nutritional, between inorganically and organically grown plants.

Why, then, the students want to know, is it beneficial to apply manure, leaf mold, peat moss, compost, and other organic materials to the soil? The answer lies, not in the plant, but in the soil itself. Soil is comprised of various-sized particles of degraded rock wetted by a solution containing organic and inorganic materials, together with organic remains of various kinds of creatures, large numbers of living bacteria, fungi and algae, occasional small animals, and a system of air spaces permeating the entire mass. This elaborate mixture of components is not static; on the contrary, it is constantly undergoing transformation. As the organisms grow, the available nutrients in the soil solution and the organic remains are used up. In compensation, these organisms secrete materials that solubilize the rock particles, making new minerals available for plants, and also glue soil particles together into large crumbs, keeping the soil well aerated and in good "tilth" for plant growth.

If the organic matter of the soil is depleted, then the activity of soil microorganisms diminishes and soil quality may deteriorate. Soils poor in organic matter characteristically have poor water-holding capacity, deficient mineral nutrients in the soil solution, and a compacted texture so deficient in air spaces that roots cannot respire properly. Plants growing in such a soil may be mineral deficient for any one of these reasons, and it is to be expected that the addition of chemical fertilizers would only partially alleviate their mineral deficiencies, while manure or other organic additives would do a more complete job.

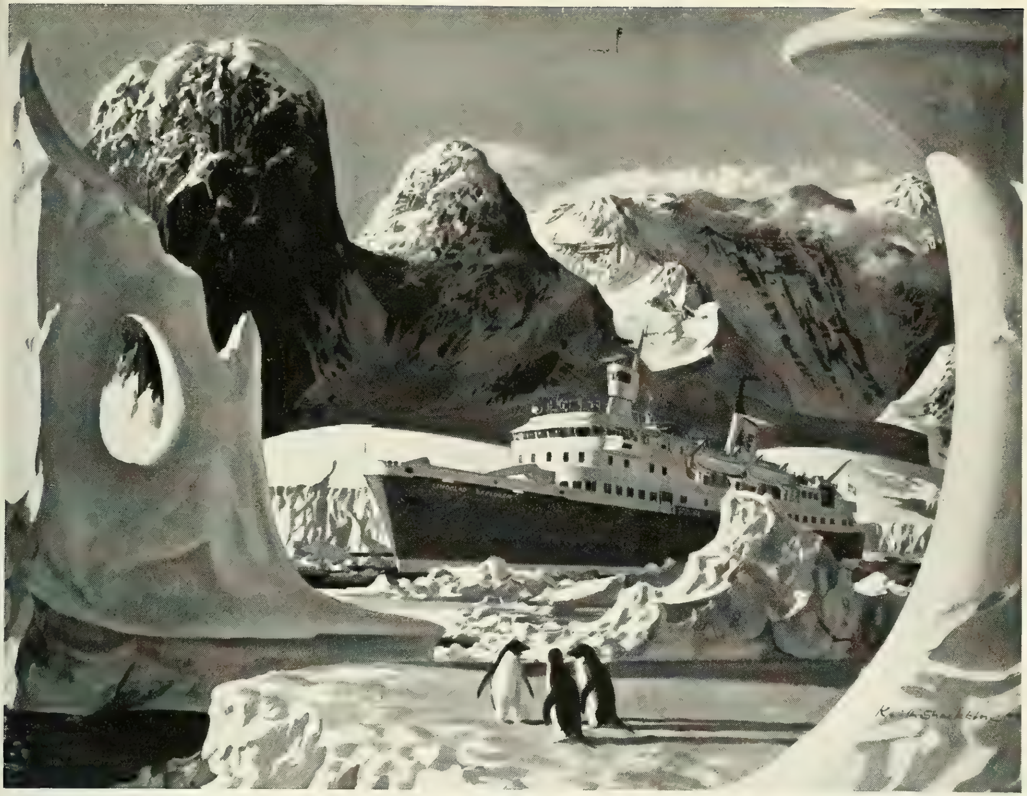
If, however, the soil has adequate organic matter to sustain its population of microorganisms and to maintain its proper structure, then the addition of chemical fertilizers is sufficient to produce optimal growth and chemical composition of the plants growing in the soil. The best proof of this statement is that plants can be grown from seed to seed in synthetic chemical solutions, entirely without organic addenda of any kind, and without even the physical support furnished by soil. Such plants are as capable of supporting the growth of the animals that eat them as are "organically grown plants."

These are facts, as certain (and as tentative) as any I know in science. Yet, I think it is fair to say that they were not really believed by some students in the class who are emotionally committed to "organic gardening." This is true partially because they are in revolt against "the establishment" and the synthetic, plastic world it has created. This leads them to propose impossible additional conditions before they will believe the facts cited above. "How do you know that there aren't undiscovered vitamins or growth factors that you can't analyze for?" Of course, scientists don't know, but point to the fact that synthetic diets made of known growth factors will support normal growth of test organisms, including man, and will support reproduction of test animals, such as mice and rats, over several generations. This puts the burden of proof for other growth factors squarely in the skeptics' court, but many of them feel no necessity to prove anything; they are content to reiterate the possibility that there is more to know about diet than we now know, without being more specific and without paying regard to the usual rules of evidence.

My advice to devotees of organic food is to pay the extra cost of such foods if they wish to avoid some pesticide residues and preservatives, but not to do so under the illusion that plants grown on organic media are necessarily any better than plants given an optimum mixture of chemical fertilizers. It is doubtful whether such advice will be taken.

In a follow-up discussion, I asked how many students regularly consume vitamin pills. About one-third of the class raised their hands. I then pointed out that the body needs only minute quantities of vitamins, that a typical Yale College diet more than adequately provides the quantities needed, that excess vitamins are merely excreted, and that massive quantities of certain vitamins could actually produce harmful effects. The students listened respectfully, but later queries revealed that practically none had changed their habits and continued, often at great personal expense, to pop useless and perhaps harmful pills as part of their daily routine. They did not really counter the evidence I advanced, nor did they change their way of thinking. They continued a daily practice that was demonstrably illogical, yet somehow computable to them. I conclude that the Yale undergraduate, like others in the community, does not behave like a completely logical animal, cherishes his prejudices dearly, and treats science and scientists with interested attention, but not with complete trust.

Arthur W. Galston teaches biology at Yale University.



Prophylactic Services of the Cleaning Shrimp

by Carl Roessler and Jankees Post

Fast, effective relief!

Stop minor itching and irritations Without causing stomach upset

(Caution: May be habit-forming)

In the countless generations since the seas began, many involved relationships have developed among the creatures of the coral reef. The most common and best understood, of course, is the elaborate ritual engaged in by the hunter and the prey. But other, complex almost-ballets fill the daily life of the reef; many of these have only recently been observed and are part of such an intricate mosaic that major studies will be required even to begin to comprehend them. Why, for example, do whole sections of coral reef suddenly sicken and die, and why do certain algae and anemones immediately invade and overgrow these graveyards?

One relationship, which was first described within the past twenty years, is the phenomenon of cleaning, a symbiosis in which certain species remove irritating parasites—which are their food supply—or "treat" wounds as a service to other species. Certain French angelfish and Spanish hogfish, for example, spend their youth as cleaners but stop when they reach adulthood. Other species spend their entire lives providing this service.

One group of cleaners, which combines color, delicate grace, and fascinating function, are the reef shrimps. But these tiny crustaceans, numbering in the uncounted billions in the world's seas, are hardly the best known of their class. The lobsters, crabs, and commercial open-water shrimps, which adorn both sea and table, or the enormous bulk of the deep-sea, shrimplike plankton called krill, which forms one of the sea's largest food supplies, come to mind more quickly. But when seeking beauty rather than food, the cleaner shrimps of the reef are always worth the search. Four species frequent the reefs in the Netherlands Antilles.

The most easily found is the brilliantly hued *Periclemenes yucatanicus.* Seldom reaching an inch in length, this exquisite creature hides amid the stinging tentacles of the anemone *Condylactis gigantea.* The anemone seems to provide lifetime protection for the otherwise quickly devoured shrimp, but what does the smaller symbiote do for its well-armed host? In aquariums it appears to clean the anemone.

In the area we observed, each *Condylactis* had but a single adult shrimp symbiote of this species. In three years of constant diving, we never saw more than one adult shrimp per anemone. This local observation differs from that of the late Conrad Limbaugh, who found *Periclemenes yucatanicus* in pairs or even aggregations of five or six. On another point, however, our observations and Limbaugh's are identical: this shrimp never seems to leave its anemone host to clean fish, apparently spending its entire adult life within the protective perimeter of the *Condylactis*' tentacles.

Another tiny shrimp, *Periclemenes pedersoni*, has a larger behavioral repertoire. It will clean not only *Condylactis* but several other anemones as well, and will, at a moment's notice, clean parasites from certain of the passing fish. Constantly lashing its antennae back and forth to advertise its availability, this shrimp is easily visible at a distance to any fish needing its assistance. Leaping from its anemone perch at a "truce" signal from the parasite-plagued fish, this almost transparent shrimp picks the irritants from the scales of its verte-

Not tiny time pills, but the knoblike appendages of a sea anemone provide a home for a cleaner shrimp, a *Periclemenes pedersoni.*

Telltale antennae apprise passersby of the presence of a cleaner shrimp, *Hippolysmata grabhami*, backed into a coral cleft.

brate visitor. Unlike *P. yucatanicus*, this shrimp is willing to leave the armed confines of its host anemone. Individuals and groups of six to eight can be found on sponges or other highly visible stations, but never far from the protection of their anemones.

The communication that precedes fish cleaning involves a fixed ritual, which is easily observed in the larger cleaning shrimp such as *Stenopus hispidus* or the more retiring *Hippolysmata grabhami*. Both these cleaners are usually found by searching small clefts in the coral for the telltale long white antennae that mark them. While the shrimp's body is generally not visible, the waving antennae extend beyond the sheltering coral like a neon sign advertising the occupant.

These large cleaning shrimp also seem to have fixed abodes, where a diver can find them day after day. More important, this fixed address is known by the larger territorial residents of the reef, such as the groupers and moray eels. These large predators suffer from almost transparent parasites, isopods and copepods, which are actually relatives of the very shrimp that provide the cleaning service. Close inspection often reveals these tiny parasites moving about on a grouper's scales. Especially when a grouper flushes darkly, the diver will see small white spots, shaped like horseshoe crabs, skittering about the head and eyes of the fish.

When in need of cleaning, a grouper or moray will approach a hollowed-out section of coral where the cleaners live, often entering via a "back door." We feel they probably adopted this method of entry because it hides their bodies from the view of even larger predators and allows them to scan the reef while being cleaned. In these larger creatures the signal requesting cleaning seems to be cessation of movement, sometimes accompanied by the flaring of fins and gill covers. The moray or grouper adopts a position of rest and the cleaner shrimp immediately goes to work. *Stenopus* maintains its position on the coral and reaches out with long claws to pick parasites, but *Hippolysmata* leaps aboard the fish or eel and crawls over its body searching for the irritants.

This whole procedure is markedly different from the cleaning of other reef fish such as bonnetmouths, wrasse, and parrotfish. Certain species of cleaners appear to specialize in cleaning certain "customers." For example, bonnetmouths will be found in clusters about juvenile Spanish hogfish, but goatfish seem to approach only juvenile French angelfish. Wrasse and parrotfish use

Two barbershop shrimp, ***Stenopus hispidus,*** **finish cleaning a moray eel, top, which has been startled. At left, a shrimp keeps watch from a nook in the reef.**

cleaning gobies or the small blue anemone shrimp *Periclemenes pedersoni* rather than *Stenopus* or *Hippolysmata.*

Wrasse and parrotfish often request cleaning service by adopting a vertical position—"standing on their heads" or "standing on their tails." Since the usual orientation of fish is almost always horizontal, the sight of a fish holding itself erect by waving its pectoral fins is easy to spot amid other reef activity. The adoption of a vertical orientation seems to involve a good deal of effort and would appear to be impractical for the larger morays in particular.

Another signal for requesting cleaning is color change. We have observed a group of yellow goatfish move as a school to the cleaning station of a juvenile French angelfish. All of the goatfish came to rest on the sand, and one changed from its normal white and yellow color to a startling blood red, whereupon the cleaner began work. When we interrupted the scene, the red goatfish reassumed its normal color, and the school swam away. The entire procedure was repeated a half-dozen times; each time only one fish of the school changed color and received service.

The removal of parasites by the shrimp must be pleasurable and necessary for the fish: they definitely do not like to be disturbed while it is in process. Even when a diver comes near, the fish being cleaned attempts to remain calm and let the shrimp work. Especially in the larger fish or eels, the diver can observe an increase of stirring in the client as the intruder moves closer. In the end, the moray or grouper will distinctly shudder, and the cleaners retire instantly to the protection of their coral head. At this point, particularly in the case of the larger morays, the next move is best made by the diver.

How important is the cleaning service offered by the shrimp? To find out, Limbaugh removed the cleaner shrimp from two coral heads. Within a few weeks there

A tiny cleaning shrimp, *Periclemenes yucatanicus*, scuttles among the armed tentacles of a sea anemone on a Caribbean reef.

were fewer fish at these two coral heads than at others in the area, and many of these showed frayed fins and ulcerated sores. Attempts to repeat this experiment have shown no such results, however.

On two occasions I have observed wounded morays with cleaners picking at their wounds. In one case, a badly mauled spotted moray that had lost an eye remained motionless as a cleaner moved quickly over the wound.

One might expect that, in return for their crucial services, the cleaner shrimp would be immune from attack, but this is not so. During the clearly signaled truce of the cleaning ritual, the shrimp is not attacked. But at other times the cleaners appear to become prey, for they have been found in the stomachs of groupers on several occasions. This might explain why *Stenopus* and *Hippolysmata* live in protected crevices with only their advertising antennae visible, and why *Periclemenes yucatanicus* and *P. pedersoni* live on host anemones.

One of the most interesting of the reef shrimps is the mantis shrimp. This formidable predator—solitary, drab, and vicious—is the opposite of the cleaner shrimp. Those we have met are dull white and blend with the white sand in which they dig burrows up to three feet deep. When a diver accidentally puts his hand near a camouflaged sand burrow (as my 13-year-old son did), he is immediately confronted by its raging, snapping occupant.

The mantis shrimp cleans no one and seems to attack anything that passes by. What look, and work, like praying mantis claws are actually one elongated pair of amazingly effective mouth parts. Strong and sharp, they seem to have no real equal among familiar terrestrial insects. Praying mantis claws reach forward above the prey and snap downward, while the bottom-dwelling mantis shrimp shoots its specially adapted lower jaws forward beneath the prey and snaps upward. But functionally, the two mechanisms are almost identical.

These few reef shrimps are only a small percentage of the many species of crustaceans that throng the sea. But while they do throng the sea, we must end on an ominous note. We have dived on reefs where spear fishermen and other human killers have wiped out the large territorial fish such as groupers, and the repercussions have reached even the shrimp. In addition, the popularity of salt water aquariums has caused professional collectors of tropical fish to ship large numbers of *Stenopus hispidus* to stock wholesalers in America and Europe. On reefs that have been heavily worked, the effects are dramatic. These desolate, empty reefs echo to the loss of the big sport fish, and one searches in vain among the coral ledges for the telltale white antennae of their little servants.

Shrimp are not the only cleaners on the reef. Here a yellow-tailed goatfish has turned rust red, its signal to a French angelfish that it wants to be cleaned.

Look Out, Hercules

by John P. Wiley, Jr.

Harry had been trying to find the variable star for an hour. He was losing his temper, starting to say nasty things about V Bootis, the star he couldn't find; gamma Bootis, the guide star, which he could find; and the makers of his telescope, which somehow had to be at fault. He decided to give the variable star one last chance to be where it was supposed to be.

First he aimed his telescope at third-magnitude gamma Bootis; then, with the wide-field eyepiece in place, he slowly swung the tube north and west, moving a precise number of fields of view from the bright star. He came to the same star field, the one that looked so much like the finder chart on the table beside him. There was the sideways W he was looking for, and that bright pair; but there, too, were stars that did not appear on the chart, too many such stars to let him believe for a moment that he had discovered a nova. He knew he would never see V Bootis.

The salty sting of frustration surprised him. He'd try again tomorrow night, when his eyes weren't so tired. He wished the doctor had not told him that alcohol tends to destroy night vision. Irritated, he lay down on the plastic-webbed chaise lounge. He had told his wife that he used it to watch for meteors, and sometimes that was true. But the chair's angles reminded him of a captain's fighting chair on the bridge of a destroyer, and sometimes, Harry lay on the lounge to pilot the earth through space.

He was facing east. It was nearly eleven o'clock and the summer triangle was climbing the eastern sky; Leo was sinking in the west behind him. He half-closed his eyes, concentrating all his consciousness on feeling the earth move, letting out the clutch. Now he felt it, the speed of rotation carrying him toward the eastern horizon at 750 miles an hour. Spaceship Earth was becoming real, spinning like some gigantic dynamo.

Sensing the spin was always easy. Now he thought about the sun, hidden by the bulk of the planet below him. He willed himself to feel the earth moving through space as it streaked along in its orbit around the sun at 18 miles a second. He did not feel it until he began to sense the centrifugal effect of the earth's curving in its path. The earth was turning in toward the sun by a ninth of an inch every 18 miles, curving to close the ellipse of its orbit.

Adding the proper wobble was more difficult yet. Harry had to speed up the rhythms of the world, pushing ice sheets up and down the planet like window shades in a speeded-up cartoon. To really feel the wobble, he had to rotate the globe so fast it was only a blur, and whip it around the sun at a dizzying velocity. The wobble was still very slow, but by tensing every nerve, Harry could feel the earth's axis turn through 47 degrees. In his pilot's chair he began to sway slowly from side to side.

(Long ago he had given up the wholly separate Chandler wobble, which only moved the earth's axis a few feet. It was real, but too small to matter: Harry had bigger things to think about.)

Now, with his spaceship rotating, revolving, and wobbling, Harry scrunched down into his chair for the really big motions. He leaned his head back and aligned himself with the sweep of the galaxy.

Slowly, slowly, he let his senses feel the ponderous turning of the galaxy, a hundred billion stars acting as the atoms of a cosmic Frisbee. Slowly the galaxy spun (clockwise, if you looked down from its north pole), every star in the sky and the blur of the Milky Way turning, the flywheel of the gods.

Harry had the galaxy spinning now if spinning was the proper word. It would take 200 million years for the sun to get around once. It had gone only one-third of the way around since the last of the great dinosaurs died. This was not to say that the sun was loafing along. It had to move at better than 125 miles a second just to keep its place.

Now came the best part. Rather than simply keeping in place and flying the solar system around and around the galaxy like some kiddy car on an amusement-park track, Harry made his move. Smiling like Snoopy taking his doghouse up before dawn, he pulled the earth (and the sun and the rest of its entourage) out of the stellar formation and sent it flying through the neighboring stars at 12 miles a second, aiming for a spot east of the keystone in the constellation Hercules. Harry lay back in his chair, eyes fixed on Hercules, and soon the stars at the edges of his vision began to slide by. Those ahead moved apart, like the trees in front as you walk through a forest, and those behind him closed together.

Harry knew he was moving in still one more direction, but chose to ignore it because he did not know what direction. The universe itself was expanding, and the galaxy was hurtling along, destined by the explosion that blew up space itself to moving always farther and farther away from every other galaxy.

Harry had given up trying to feel this motion; he had no frame of reference by which to gauge it. It was

like piloting an airplane over an untraveled ocean on a dark night: you could fly for hours and nothing would look any different. You could not prove that you had moved at all.

Harry concentrated on what he could see. He gripped the arms of the chaise, keeping a sharp watch on the interstellar space ahead of him. The stars of Hercules seemed to be growing brighter as he slipped silently toward them; the fuzzy patch of light that marked the cluster Messier 13 seemed to be breaking up into individual stars.

"Don't forget to put out the garbage, dear," his wife called from an upstairs window. Harry stared at the darkened house, looming up against the northern sky. The galaxy, the sun, the earth, all stopped moving. He got up slowly, threw a tarp over the telescope, picked up his charts, and walked into the house.

Another Dream Lost The solar system became a lonelier place this year when we had our first close look at the moons of Mars. Phobos and Deimos, or Fear and Panic, if you prefer translation, look something like badly pocked potatoes; they look nothing at all like artificial satellites put in orbit in a last bid for survival by the technically advanced inhabitants of a dying planet. And the craters almost certainly indicate that the two moons were in orbit long before the period 1862 to 1877.

The Martian moons have been famous beyond their size ever since Jonathan Swift correctly described them in 1726, some 150 years before they were discovered by Asaph Hall. In this century Edgar Rice Burroughs, in a series of novels, created an image of them hurtling across the Martian sky. (Actually, seen from the surface of Mars, they would appear to be barely moving.)

In 1959 the Soviet astronomer I.S. Shklovskii proposed that the moons were hollow, that they were really artificial satellites, orbiting habitats for Martians. He advanced the idea to explain why Phobos is accelerating and moving closer to Mars, a motion that will change its place in the sky (seen from Mars) by 4 degrees in a century and that will bring it crashing to the surface in 10 to 20 million years. Only hollow objects, Shklovskii argued, could be light enough so that even the extremely tenuous outer atmosphere of Mars could exert enough drag on them to shrink their orbits and thus actually accelerate them.

Another Soviet writer took Shklovskii's idea a step further, suggesting that the moons were launched sometime between 1862 and 1877. F. Zigel pointed out that Sir John Herschel did not see the moons at the favorable opposition of 1862, but Asaph Hall found them with a smaller telescope 15 years later. Herschel did not see them because they were not there in 1862, Zigel argued.

Now Mariner 9 has sent back pictures of both moons—misshapen chunks of planetary debris. They are obviously not the product of intelligent beings. Of course, if you were a Martian and wanted to be left alone, you would not build a shiny space station that cried out its artificial origin. Instead you might employ camouflage and try to make your home in space look like an old chunk of rock.

Phobos, the larger of the Martian moons, was photographed earlier this year by Mariner 9. It measures about 20 by 25 miles; the shadow-filled crater at right center is about four miles across. The craters show great age.

Celestial Events

by Thomas D. Nicholson

The Moon: The early crescent moon, in the mid-May evening sky, will be very close to Venus and Mars in the southwest on May 15. Setting later as it waxes, the crescent becomes first-quarter moon on May 19, when it sets about midnight, and gibbous thereafter, setting between midnight and dawn. Apogee, where the moon is farthest from earth, occurs on the 25th, and on the 27th the moon becomes full. During early June, the waning gibbous moon rises before midnight and remains in the sky past dawn, becoming last-quarter on the 4th (when it rises at midnight). It passes through perigee (nearest earth) and reaches new moon on the 11th. The early crescent should be visible again in the evening sky by June 13, when it will again be near Mars.

The Planets: Venus and Mars remain close together in the evening sky as they move from Taurus into Gemini. Both have now moved well to the east (left) of Saturn. They set about two hours after sundown in mid-May, but earlier by the end of May. By mid-June they are too close to the sun to be seen. Saturn goes through conjunction in late May and enters the morning sky, where it will become visible by late June. About the time that Venus and Mars are setting in the late evening, Jupiter is rising, low in the southeast among the stars of Sagittarius. Close to the moon on the night of May 29–30, Jupiter will be low in the south during morning twilight. Mercury remains too close to the sun all month for observation.

The Stars: In mid-May the stars of spring in the west and the summer stars in the east dominate the early evening sky, with the Big Dipper high in the north, above the Pole Star. By morning, the autumn stars are rising in the east.

May 15: The moon is in conjunction with Venus and Mars and occults Mars over parts of Europe.

May 17: Venus and Mars are in conjunction.

May 26: Venus becomes stationary in right ascension and begins its retrograde (westward) motion as it approaches conjunction with the sun. The sun now is approaching the planet rapidly from the west.

May 28: The full moon occults Antares, in Scorpius, over central and western North America, at about 4:00 A.M., EST.

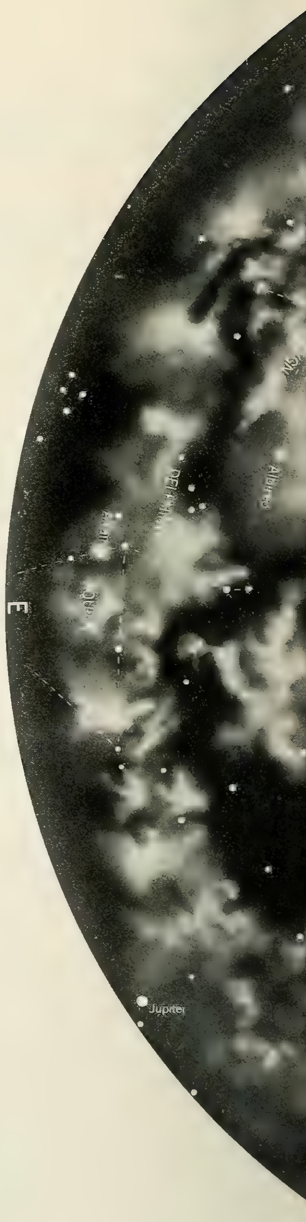
May 30: Jupiter is in conjunction with the waning moon.

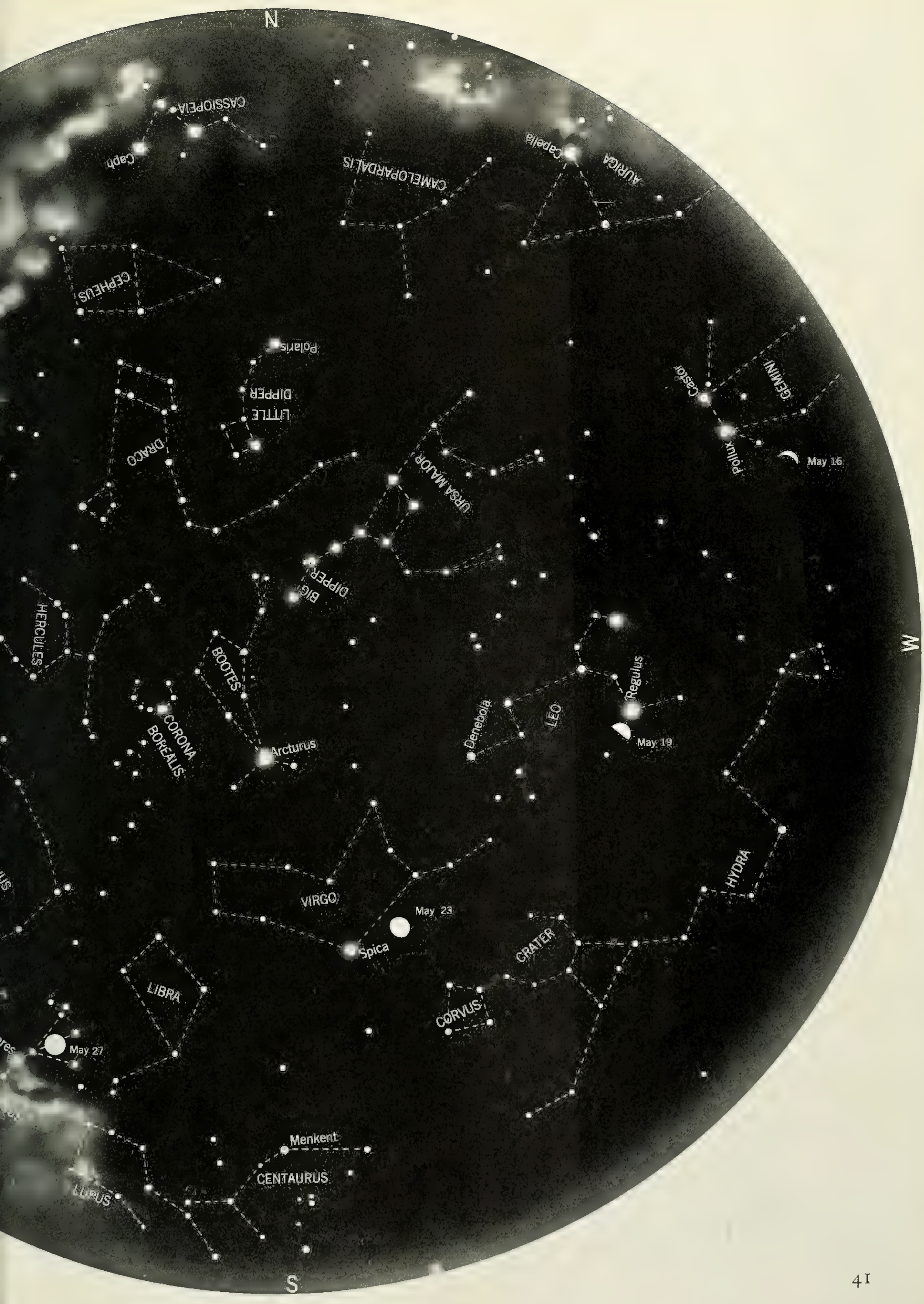
May 31: Saturn is in conjunction with the sun and now enters the morning sky.

June 4: Mercury, in superior conjunction, passes beyond the sun and becomes an evening star.

June 13: Mars is in conjunction with the moon and is occulted over parts of Africa.

★ Hold the Star Map so the compass direction you face is at the bottom: then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:25 P.M. on May 15; 9:20 P.M. on May 31; and 8:20 P.M. on June 15; but it can be used for about an hour before and after those times.

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The Greening of Doctor Hogue

When a biologist from the gray and brown American Southwest arrives in the Costa Rican rain forest, he receives one overwhelming impression, as selections from his tape-recorded journal show

by Charles L. Hogue

I awake to the sound of birds and katydids and the droning of cicadas. From my window I can see a solid wall of green foliage, broken only by the vertical, light-colored trunks of various trees and the occasional deep-brown branches of palm trees. Vines climb up the trunks of many of these trees, so my first sight each morning is the forest. It imposes itself upon me from the very instant I wake up, and stays with me all day until I go to bed at night.

This feeling of greenness is beginning to come over me. I've felt it before on other trips to the tropics, especially during the rainy season when the vegetation is even greener than it is now. One's eyes become addicted to green as the predominant color. Suddenly, I can't remember the grays and browns of the temperate regions, especially those of the southwestern United States, southern California, where I live. No, the green becomes ingrained. It seeps into your skin and saturates the retinas of your eyes. It is almost as if your whole visual system and brain were impregnated with the forest chlorophyll itself, and you begin to photosynthesize the light, and inside your head it takes over your thinking.

Let me describe the scene that is before me at the present time. There stands a large pool of water, some fifty feet long, about twenty feet wide and three feet deep. I've watched this pool of water grow with the rains; then recede. Now it contains half of what it did when I first arrived here, and the stream is running about half a foot below what it was. The pool is exposed to the full sunlight. It looks like something that might be observed on the planet Venus. Cords and wisps of intensely green algae are proliferating, lying in a slimy tangle. The algae are gradually taking over the pond, and the water in the pond is assuming the same green that prevails in the leaves of the trees. It seems almost as if the water has dissolved the green from the air, put there by a gaseous aerial absorption, and is concentrating this green and turning it into the stringy cords of algae.

It is another emphasis of the movement of green from one state of matter to another, the solid of the green leaves of the trees to the gaseous state of dissolution in the air, to the liquid state in the water of this pond, and gradually back to a solid state in the form of algae. It is another kind of cycle—a cycle of green, a cycle of the metamorphosis of chlorophyll. Perhaps it exists only poetically, but it does seem to be going on here. Or could it be that the rain that falls on the leaves absorbs the green and transfers it down the trunks of the trees and off the tips of the leaves and into the water of this pond, where it is again concentrated in the swirling masses of algae? What sort of metamorphosis can be imagined with the green that is so prevalent in everything that exists here?

I am even turning a little green myself. I have mentioned how it affects the eyes. It absolutely affects what I wear. My belt and machete case, left unattended for two or three days, sprout a lovely greenish growth of fungus and I have to brush it off. My shoes turn this color if left unwashed. My briefcase, nicely polished with wear when I came here, has been sitting unattended: I looked at it the other day, and on every exposed piece of leather—inside and out—I found a carpet of greenish mold an eighth of an inch deep. It's impossible to escape from it. Even my feet turned green, stained by my olive-green safari boots when I was caught in the rain while walking back to the research station. To look at them was like looking at the feet of an imaginary green child from another world. My feet are still stained green, a color entirely appropriate to this place. I feel that even after I have left here and returned to Los Angeles, for several days green water, like some biological ink, will run down the bathtub drain after I bathe.

I am outside the research station now and looking around for a good spot to sit down, a spot where it is quiet. Even though this is a very peaceful place, it is difficult to find a spot where there's little noise because of the abundant animal life, particularly birds. At this time of the evening (it's about five o'clock), the parrots are coming in in great numbers. They find themselves a good tree and they come in and mass, making as much noise as they possibly can.

I just spotted my first toucan. I

don't know what species it is, but it's a mostly black bird with yellow markings and like all toucans, it has an enormous beak. They are amusing to watch when they fly because of their long, protruding bills. The bird looks almost as if it were pushing a banana along in front of it. I've heard people refer to them as flying bananas, but this is an affront; they are beautiful birds, and their colors are brilliant. In the evening, they sit in the dead or leafless trees around the edge of the station and make their calls.

I can pick up one new sound after another: katydids, cicadas, crickets, frogs, some with the most bizarre sounds I've ever heard. As I listen, I hear the sound of someone vomiting, the sound of a Coke bottle being hit with a sharp metal instrument, and sounds simulating the chirping and cheeping of birds. They all blend together and make one sound, a singular sound reproducible nowhere else on the earth, except in the recesses of the rain forest.

I'm in a little clearing here. I look around me 360 degrees, and see a wall of green punctuated only by the upright white trunks of many of the trees. It's common for trees here to have light-colored trunks. But when you look at a tree trunk here you don't always see the trunk itself. Dozens of different forms of lichens grow on the bark of the trees and give them colors and textures strange to trees. And as I look around, I see this undulating and pervasive wall of green, and a few tree trunks, and I feel as if I'm on a reverse island, an island that's not surrounded by water that I can look down upon, but rather an island that's depressed, and I have to look up, up to the sea of green around me.

This afternoon I made a trip down to the nearest settlement, Rincón, which is some miles from here. Rincón, which means "corner," was chosen by its founders because of its location in the upper end, or corner, of the Golfo Dulce. It was an arduous journey, but one that gave me great satisfaction. I went down there just to introduce myself to the people, and made the journey back in the sun of the afternoon; but I did some things, some things happened to me, that made me realize, made me remember once again, that I'm an animal. I don't mean this in a degrading sense, but I mean that it made me remember that I'm made of flesh and blood and that I have body systems and functions like those of other animals. We tend to forget these things when we live in the city. When we get into an automobile and go to work, sit behind a desk, and go through the motions of putting together a work day, we constantly de-emphasize our human nature. I think we actually forget that we are humans, and by forgetting that, we forget that we are also animals.

For the first time in many months I felt the taste of salty sweat in my mouth and on the tip of my tongue, as it dripped down off my nose and upper lip. I stopped for a moment to rest in the shade and looked skyward to see a vulture circling overhead. Suddenly, I felt the burn of salt water in my eyes as the perspiration ran down from my

forehead. These are joyous things. It sounds strange, but they're joyous because they do make you remember your connections, your relationship with the natural world—not only looking at it, experiencing it with the eyes and ears, but actually working with it, letting the air run over your body, water run through your body and out your pores, feeling the hot sun beat down on your forehead. These are all sensations that gave me some real joy this afternoon, though I wasn't even in the forest. My muscles have gotten flabby, but I made the trip all right and I'm very happy that it came off so well.

In my few minutes of peace and quiet, usually after I awake in the morning, before I get out of bed, and before I get to sleep at night, I think about this forest and what it is. As a biologist, I'm interested mainly in its ecological aspects, and I have read textbooks and many papers about the ecology of the rain forest, but I still don't see it all. I say *all* because it is difficult not to think of the forest as a single unit, as a single organism rather than a group of associated organisms. As I look around me, I don't see a group of trees inhabited by living animals and insects; rather, I see one tree, one thing, one organism with its elements partly hidden, partly exposed. Much of this is due to the density of growth, the closeness of the trees and the intertwining of the branches, so there actually is an interconnection, a physical touching of the different elements of the rain forest.

This is not found in many other types of plant associations, at least not in the ones with which I'm more familiar—the desert formations of the Southwest, where the trees and other plants are wildly scattered. Because of the scarcity of water they are spaced out over the land, and as you walk among them you see them as units separated from one another. But just the opposite occurs here. You see the trees as a part of one another—they are touching, they are in intercourse and form a real network that can be thought of as a whole. This wholeness has been appreciated by scientists for a long time, and I think it is one reason that the rain forest has served as the primary model of an integrated ecosystem. Rain forests are out of the way, they're off the beaten track, they're in the tropics, they're difficult to reach. Nevertheless, the relatively few early visitors to the rain forest, those who were educated as biologists one hundred years ago, when ecology was just being born, were struck not only with its great beauty but also by its continuity and by its singular aspect. When life is so exuberant, so abundant, and so many things are going on, biological interrelationships become gloriously conspicuous.

I must mention that today I saw another of those always startling creatures: this one, a tiny larva of the lacewing fly, which has the curious habit of picking up bits and pieces of debris, little chips of wood, little flecks of dirt, pieces of leaves. Somehow it affixes these to its back. When this little animal walks along, it carries its pile of rain forest. The insect puts this habit to use when it stops, however, for it normally rests on bark that is encrusted with lichenous growths. When it holds perfectly still among the growths, it blends in perfectly with its background. So its burden is, not a burden, but a suit of camouflage that protects it in true mimetic fashion.

As I look into the gray sky, I realize what little dusk there is here in the tropics, in the midlatitudes. Those of us who are used to the twilight that comes with the dawn and the dusk of every day in the temperate regions rarely get used to the phenomenon of the tropical sun coming up and going down with a thud. Right on schedule, the sun pops up every morning, pops up over the horizon without announcing itself; and after a neat twelve hours, drops abruptly across the opposite horizon and it's night. Twelve hours of night and twelve hours of day, twelve hours of night and twelve hours of day, and thus it goes on throughout the year with little variation.

It's a little later now; the sounds around me are increasing in intensity and can be described (if I had to do it in a single phrase) as an intense buzzing, the same kind of a sound I remember at home on a rainy morning, when the high tension wires—wet from the fog and dew and the recently fallen rain—would buzz and hum. But here, of course, the sounds are not coming from a metal wire but from hundreds of different kinds of live organisms, hundreds of animal musicians, most of which are insects, primarily cicadas and katydids. The sound is much the same, and the feeling you derive from it is much the same. It is a feeling that the air around you is alive, your environment is alive, the very air you take into your lungs is alive. You *feel* the life around you. In the temperate areas, so much of our lives seems to be played out in a dead environment. We have asphalt, we have concrete, we have bricks and mortar and plaster around us, and we have sound emanating from machines, which are built with dead material: steel, iron, copper. But here the things around you are alive, you breathe in life, all your senses are perceiving life. The experience is luminous. Absolutely luminous.

Almost every night there are crystal-clear skies and I can see the stars. Because of the latitude here I cannot see Polaris, the North Star. I could if I were on the ocean because I am at 9 degrees north latitude and the star should appear at 9 degrees above the horizon. However, there are hills to the north of the station, and Polaris hides just over the crest of this range of hills. I can see the Big Dipper swinging around, arching around the sky, around Polaris, but I cannot see the star itself. Oh, my God—behind me, fantastic, one of those beetles, those fluorescent beetles. There's another one, absolutely incredible—it's like a fireworks display. There's a beetle here of the genus *Pyrophorus*, which has two headlights on the front of the thorax and another light organ on the underside of the abdomen . . . there's one next to me. And there's another out over the stream. They're not like fireflies, which flash on and off. They glow, they glow in a steady stream of light that flows through the forest. I just

Continued on page 85

The Fiery Sun

Missing subatomic particles, an unexpected flattening, waves radiating through sunspots: these are just some of the new mysteries that surround our nearest star

by Jay M. Pasachoff

G. K. Chesterton marveled that men could live with a light in the sky they could not look at. Our first-grade teachers told us that all life on earth, including our own, depends on the energy of the sun. Just 35 years ago we finally figured out how the sun can pour out energy at such a prodigious rate, eon after eon. Today, as scientists around the world continue to study the sun—from its deepest core to its outermost gases—we are finding out that we still have a lot to learn about the sun.

We are almost certainly correct

Curtains of luminous gas hover tens of thousands of miles above the horizon of the sun.

about the basics of where the energy comes from. Atoms of light elements merge to form atoms of heavier elements, liberating energy in the process. This is nuclear fusion, the same process that can produce the energy for weapons of war and someday may supply the heat for power generation. Beneath the surface of the sun a number of fusion processes are going on, and we are now trying to observe them directly.

In the simplest process, four hydrogen atoms combine, in a series of steps involving carbon atoms, to form one helium atom. At the end, 7/1000 of the mass of the original hydrogen has disappeared, transformed into energy according to the formula $E = mc^2$ (the energy liberated by the loss of matter equals the amount of matter times the speed of light squared; the speed of light is, of course, a very large number).

A few years ago, Raymond Davis of the Brookhaven National Laboratory thought he had figured out a way to observe the inside of the sun directly. At various stages in the fusion process, certain kinds of spinning, subatomic particles called neutrinos—which travel at the speed of light—are emitted. The neutrino is so elusive that there is only a very small probability of its being absorbed inside the sun, so if we can detect it on earth, we are in direct contact, so to speak, with the interior of the sun.

To capture neutrinos, Davis built the strangest solar telescope of all: a 100,000-gallon tank of perchlorethylene, a cleaning fluid. A chlorine nucleus becomes a radioactive argon isotope when it is hit by a neutrino in the energy range that is expected of one kind of neutrino coming from the sun. To shield the fluid from other cosmic particles, the tank was placed almost a mile underground at the Homestake Gold Mine in Lead, South Dakota.

The tank is exposed to solar neutrinos for a few months at a time, then Davis counts the radioactive argon. But despite all he has done to improve the experiment over the past few years, he has yet to unequivocally detect a single solar neutrino. Such a negative result is very useful, especially because the detection threshold of his equipment is much lower than that required to sense solar neutrinos in the predicted quantities. Thus, there seem to be many times fewer solar neutrinos than had been thought. Extensive theoretical analyses of models of the inside of the sun are going on, and we are not desperate yet. But Davis's results are certainly troubling.

Another recent observation may also change our ideas about the sun's interior. Robert H. Dicke of Princeton has reported that the sun is slightly brighter at the edges of its equator than it is at its poles. He attributes this to a slight equatorial bulge—40 miles out of 860,000—on the solar photosphere, the visible surface. This flattening is more than the surface rotation of the sun would cause, and Dicke has suggested that therefore the central core of the sun rotates much faster: once every four days, rather than the 25 days the photosphere takes at the equator or 30 days it takes at high latitudes.

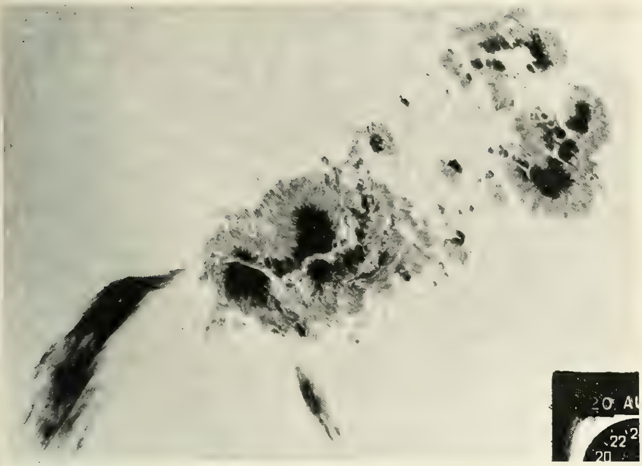
There have been a number of challenges to this theory. Some people have calculated that there would be too much friction between the core and the outer layers, while others have suggested that more light comes from the equator, not because of a bulge, but because surface features along the equator are slightly brighter than those at the poles. Dicke, in turn, has challenged these objections. The discussion bears not only on the solar interior but also on the validity of Einstein's general theory of relativity because a rapidly rotating solar interior would have other, observable consequences in the solar system. For example, the perihelion of the planet Mercury changes its position each year by an amount considered in agreement with general relativity. Dicke's rapidly rotating solar core would contribute to this change and the amount left over for relativity to explain would be less than that required by the theory.

Although we know little about the interior of the sun, we know somewhat more about its surface. Here again, however, there is much to be learned. We have a basic knowledge of what is going on, but the structure of the surface is so complicated that some astronomers despair of ever sorting it all out, although many are trying. The earth's atmosphere is a major impediment to our understanding. Its unsteadiness—the same effect that makes stars twinkle at night—limits us to seeing details on the sun no smaller than about 500 miles across. Although this one second of arc limit is a small fraction of the solar diameter, it is still larger than the structures we would like to see.

We are not yet at the point where we can get large enough telescopes into space to improve on the atmosphere-limited observations of ground-based astronomers. Ten years ago, a series of balloons was launched above much of the earth's atmosphere and sent back several excellent photographs of the granulated pattern visible on the surface of the sun. But the quality of these pictures has now largely been matched by new instruments on the earth's surface that approach the atmospheric limit, and the capability of heavier and bigger instruments on earth has added much flexibility to the kind of observations that we can make.

Three major observatories in the

Solar granulation shows clearly in a sunspot photograph taken through a red filter. At lower left and lower center can be seen the dark images of gas that was ejected ten minutes earlier from a solar flare. Recently waves have been detected moving radially outward from the center of such sunspots.



United States have new instruments to observe the sun at the highest resolution. The Kitt Peak National Observatory, southwest of Tucson, Arizona, has a huge solar telescope that is used largely for taking spectra of the sun. Light is reflected into the stationary telescope by an 80-inch flat mirror, which tracks the sun, and is focused by a concave mirror 60 inches across. The light is then spread out into a tremendous rainbow, which between the red and the blue would span a football field if one could lay it out flat at one time. Astronomers pick an inch or so for detailed study.

The spectrum of the sun shows a continuous band of color and, in addition, dark gaps in the color at particular wavelengths, called spectral lines, that are caused by the chemical elements that make up the sun. By studying these spectral lines, we can tell what elements are on the sun, how much of them there are, and the temperature and pressure where the light is coming from. We can dig a tremendous amount of information out of a tiny fraction of a light beam.

Moreover, we can use the Doppler effect to measure how fast things are moving on the sun. When a gas is moving toward us, its spectral lines are shifted toward the blue end of the spectrum; if the gas is receding, its spectral lines are shifted toward the red end. By studying Doppler shifts, we can measure velocities on the sun of less than 1 mile per second. Police use the same principle in radar speed traps, but here we are investigating the sun at a distance of 93,000,000 miles.

The Sacramento Peak Observatory of the Air Force Cambridge Research Laboratories is located on a 9,200-foot mountain peak east of Alamagordo, New Mexico. Because the earth's atmosphere is a problem not only above the telescope but also inside it, where the hot solar radiation heats up air currents, the entire interior is a vacuum. The sun's motion across the sky during the day makes the image rotate, so the central 250 tons of the telescope rotates delicately on a mercury bearing to keep up.

Here scientists concentrate on solar flares and on the spectra of the smallest segments, or elements, they can see of the photosphere and of the chromosphere, the material between the photosphere and the corona. Each small segment has a spectrum different from its neighbor. Many theoretical results have been calculated to explain the radiation we receive from large areas of the sun averaged together, but now we realize that the spectral structure of small areas is often qualitatively different. Thus we must observe the small areas in detail. Only after we have worked out theoretical models for the radiation processes going on, and the temperature and density structure as a function of position on the surface as well as of height can we apply any averaging procedures to get "typical" solar values.

I am now doing research at the Big Bear Solar Observatory, which, along with Mount Wilson and Palomar, is one of the Hale Observatories. It has been discovered that a large body of water has a moderating influence on the "seeing," the steadiness of astronomical images, so our telescopes are built on an artificial island in the middle of a mountain lake 6,700 feet high. The site has been a success, for with the twin 10-inch f/15 refracting telescopes there, our group, under the direction of Harold Zirin, has taken some of the finest pictures of solar structure.

For example, every pore and penumbral structure of the large sunspot group of last August stands out in the picture on this page. Because we have long time periods of very steady images, one can even see waves traveling at 20,000 miles per hour outward from the dark central umbras through the gray penumbras of many sunspots. This is a new phenomenon that had not been previously reported.

Near the sunspots is a dark spray of hydrogen gas that had been emitted from the sun by a solar flare only a few minutes before. We take time-lapse movies of the sun through filters that pass only one very specific wavelength of light at a time to follow phenomena such as this.

A major part of our effort is devoted to studying such regions of solar activity. Many solar physicists are working on the cause of solar flares that erupt from the sun and send off both electromagnetic radiation and particles toward the earth. We would like to be able to predict their occurrence. We now think that we can see the magnetic field that grows to form the sun-

spots and their surrounding activity within a few hours of its first appearance on the photosphere. We are thus able to follow the growth and migration of magnetic field lines across the surface of the sun and, to a certain extent, even map out the magnetic structure of the active region just from photographs of the hydrogen structure.

In the photograph on page 53, a flare has ejected a spray of material at hundreds of miles per second, and the columns of gas rise and twist. Eruptions such as these can be monitored closely, and their radio emission and X-radiation followed simultaneously. This helps us construct models of how energy is built up and stored in an active region, and of what mechanism triggers its release.

High above the edge of the sun, a filter allows us to see prominences standing tens of thousands of miles above the solar photosphere, page 49. Some prominences erupt into space, but this one was quiescent, and lasted for hours.

Also part of the Hale Observatories, a 150-foot solar tower at the Mount Wilson Observatory contains a solar magnetograph. It makes use of the Zeeman effect, in which certain spectral lines are split by amounts that depend on the strength of the magnetic field. Thus, it can measure fields on the surface of the sun. The magnetic field also coincides with the structure visible in the radiation of ionized calcium, mapping out 15,000-mile supergranules that cover the solar surface.

The solar corona, the cloud of ionized gas that surrounds the sun, extends outward into space, even including the earth in its outermost limits. Under exceptional observing conditions the inner portions can be seen with telescopes called coronagraphs. The University of Hawaii has built a new observatory on Haleakala crater on Maui to take advantage of the specially clean atmosphere there, and astronomers can observe the corona from that site on most days of the year. They use a narrow-band filter that admits mostly the green radiation from iron atoms that have lost 13 of their 26 electrons. The corona has a temperature of two million degrees centigrade, which is hot enough to tear half the electrons from iron atoms.

Many aspects of the corona can now be studied from space. The NASA series of Orbiting Solar Observatories has carried a variety of instruments, including spectrographs, that can observe the ultraviolet region at very short wavelengths that are cut off by the earth's atmosphere.

The latest satellite, OSO-7, was launched in September, 1971, and carries a white-light coronagraph. It can map the basic structure of long, faint coronal streamers that extend radially out from the sun for millions of miles. Formerly, such streamers could be seen only on rare occasions when an eclipse coincided with especially clean atmospheric conditions. The ability to monitor continuously allows us to study the formation of the streamers. One streamer has even been seen to break up dramatically just before a flare occurred at its base. Presumably it had been anchored to the solar surface there. Material accelerated downward from the disintegrating streamer may have had a role in causing the flare.

Even with satellites in space, however, total solar eclipses remain the best way to study many phenomena of the chromosphere and corona. Only in this way can we bring large amounts of sophisticated and heavy equipment to bear on the chromosphere and corona simultaneously. Such a group effort, including astronomers from all over the world, still costs less than a single satellite launch.

At the 1970 total solar eclipse, Donald H. Menzel of the Harvard College Observatory and Smithsonian Astrophysical Observatory and I led an expedition to Mexico to study the structure of the outer corona. The light that we see comes partly from the highly ionized coronal atoms, partly from scattering of photospheric radiation by electrons in the solar corona, and partly from scattering of photospheric radiation by dust particles in interplanetary space. We are measuring the relative contributions to the total radiation from the different constituents by studying the spectra and polarization of light from the corona. Light emitted by the corona itself contributes little to the total. Light coming from the photosphere and scattered by electrons in the corona, which dominates within about two solar radii of the edge of the covering moon, is highly polarized and has a continuous spectrum. The light scattered by interplanetary dust, which dominates farther away from the sun, is only slightly polarized and reflects the ordinary spectrum of the photosphere. All around us, other scientists had other types of spectrographs, radio telescopes, interference filters, and the like to study other aspects of the solar atmosphere. There are still so many unknown quantities that each major observatory can run a set of complex experiments without overlap.

Menzel and I intend to continue our observations at the next two eclipses. On this July 10, the next total solar eclipse will cut across the eastern Soviet Union, northern Alaska, and from northwest to southeast Canada. We shall be on Prince Edward Island, where totality will last slightly more than two minutes. Since the sun will be low in the sky, weather forecasts chancy, and money short, many professional astronomers will choose to wait a year, but the prox-

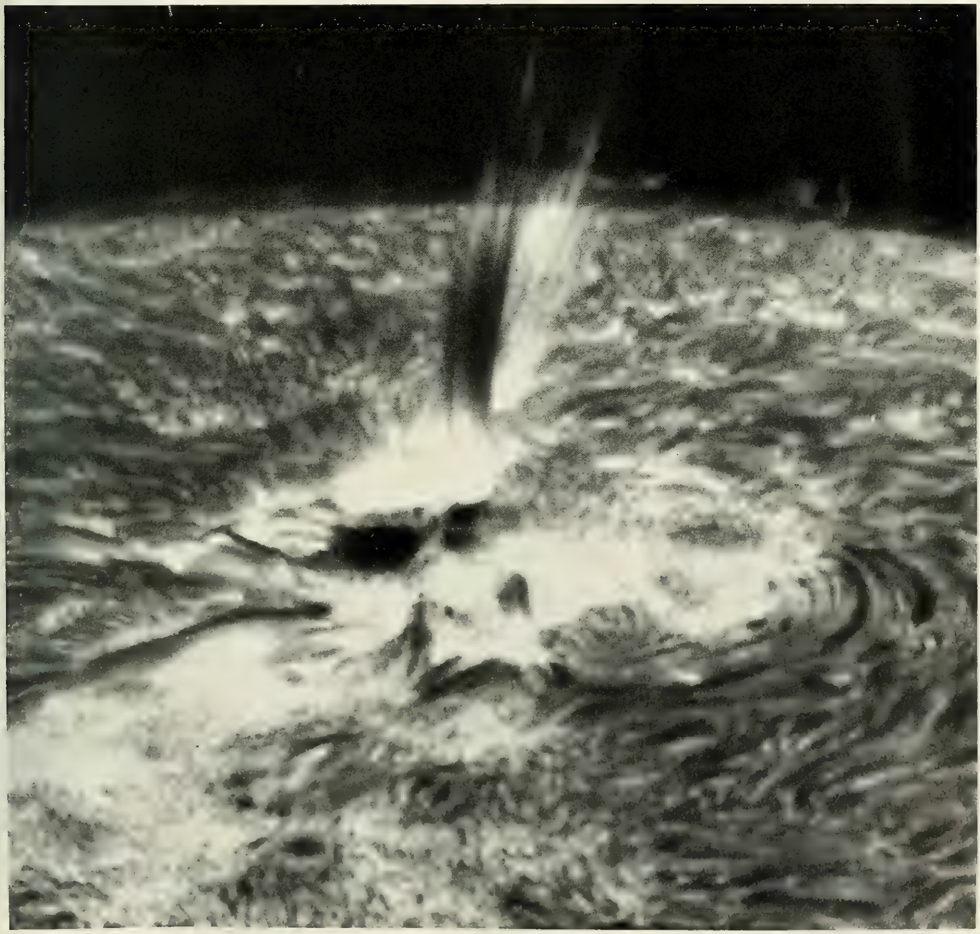
The bright flare at center, photographed in hydrogen light at the Big Bear Solar Observatory, has ejected a spray of gas. Monitoring of the solar surface has enabled astronomers to detect active regions within a few hours of their formation; they hope to be able to predict such flares.

imity of the path to populous areas will mean that many others will take the chance and travel to see this celestial phenomenon.

The following year, on June 30, 1973, will come the eclipse that the professionals will concentrate on. It will occur near the Equator close to noon; the sun will be overhead in the sky and the eclipse will last more than seven minutes. Unfortunately, the prime locations for viewing are in the Sahara Desert, but that is a mere logistical problem that will certainly be overcome to allow observations under such unusually favorable astronomical conditions. The band of totality will first sweep across Mauritania, and will be longest over Mali and Niger. The sun will be lower in the sky and totality shorter toward sites in Kenya.

The next step beyond observing the corona is going out and sampling it, and a variety of satellites are now doing just that. The solar corona expands in a solar wind, carrying charged particles to the orbit of the earth where they can be directly detected and analyzed. We have even been able to spread out satellites around the sun: Pioneer 6 and 7 in deep space and an IMP satellite in earth orbit are satellites spaced nearly one-third of the way around the sun from each other. Simultaneous observations of flares from all three satellites have provided information about the magnetic lines of force radiating out from the sun.

From the solar interior to interplanetary space, the sun's influence is being measured and probed. Each investigation is a long story in itself. An increasing number of physicists are finding interesting problems to study in solar astronomy, and the field is growing rapidly. This seems a fitting amount of attention for our parent body and nearest star, the source of all energy for the support of life on earth.



Trouble in Andalusia

by Jerome R. Mintz

To many Spaniards, the wine dark pageantry of Hemingway's Spain is just a myth kept alive by Americans and other tourists

Since the late 1950s, rural workers throughout Spain have been abandoning the countryside for the nation's cities, and for the factories and fields of the more prosperous industrial and agricultural centers of western Europe. At the height of the emigration, early in 1967, some 600,000 Spanish workers were employed in other West European countries, and since that time, it has been estimated that 100,000 people have left Spain each year to work abroad.

The effect on Spain's rural villages and towns has been devastating. In the mountains and high tablelands of the Pyrenees, Castile, and eastern Andalusia, in rugged and poverty-stricken Estremadura and in the hills of Galicia, the exodus has left some villages as deserted as they were during the plague. Often only the very old and the very young remain behind. Sometimes a community's entire patrimony, including the village church, will be offered for sale in the classified sections of the Madrid newspapers.

In the province of Cádiz in western Andalusia, the land is fertile and the climate congenial, and while the pueblos are pockmarked by their losses, they are not abandoned. In this province, there is still vitality even though the same sickness of depopulation and unproductivity exists. The town of Valle (a fictitious name), with a population of approximately 4,500, is fairly typical. Many of the families in Valle exist on money sent by husbands or sons who have emigrated to Germany, France, Holland, and Switzerland, or to urban and tourist centers in Spain.

During the year, the families of emigrant workers are kept together by the women and grandparents, but in December the men return for the Christmas holidays. Workers in Valle customarily congregate on the street corners near the plaza, and the men who have come back from other countries stand out from the rest. Everything they wear is new and shiny. Wearing suits and jackets like men of leisure, they arrive by bus with cardboard suitcases and boxes of toys. Excited children run through the streets with their presents; one has a huge life-size doll that draws the attention of a crowd of people.

The local storekeepers, too, are happy when the men return with money in their pockets. One worker orders a whole chicken from the butcher; a woman buys her husband

Would you buy a chalet from this man? A landowner in Valle, he wants to develop some of his holdings to attract tourists.

a luxury item, a bottle of aftershave lotion. For two or three weeks, while the workers are home, the streets are filled with young faces, and Valle seems to be fully alive again. Some of these men, between the ages of 20 and 40, have been lost to the town for years.

Pedro, playing cards in the cafe with his friends, is home after his first five months in Germany. His oldest son, Pepe, eleven, stands at his shoulder watching him. Pedro buys a glass of wine for Antonio, who was in Germany for five years. Antonio says he has returned to Spain to stay: "I sent home five thousand pesetas a month for 48 months, but I spent three thousand pesetas a month myself in Cologne and came home with nothing. The money I sent to the family was enough for food, but not enough to buy clothes. I won't go out again. I'm too old, 42. It's not good to be without your family. I've decided to stay here. If we starve, we do it together."

In the cafe there are tales of Germany and jokes. In one factory some Spaniards were said to have battled with a group of German workers. The police were called, but the Spanish workers would not give in. Then the German chief of police jumped on the table. "Friends," he cried, "It is good to see you so united. If you had been as united in Spain as you are today, you would not be here."

Pedro walks up the hill to his home. He has been home for three weeks and is going back to Germany today. "I've been working in Germany near Hanover for five months, digging trenches for sewer pipes. We go from town to town. When we finish one we go to another. It's a boring life. Bitter. Even now, I wake up during the night, dreaming I'm back in Germany. What is there to do when you're alone? Your family is here. You can't speak the language. We live in a rooming house arranged for by the company. We pay for it, so many marks a month. We make our own meals. There are four of us in the room. Another fellow and I take turns cooking breakfast and supper. The night before we make lunch for the next day. A fried egg or something. We earn four and a half marks an hour. I am 36 years old. We have ten children. The youngest is four months old. This is the last one. The oldest is 14, a girl. No one works in the family but me.

"For eleven years I worked on

Women migrate from impoverished mountain towns to work in fields near Jerez. As in the feudal past, a shepherd, far right, tends a landowner's sheep for rations and a small share of the flock.

Older men get together in a tavern for a late afternoon game of cards or dominos, above. When the younger men work abroad, grandparents serve as surrogate fathers in Valle families.

A boy who must work to augment the family income cannot go to school. Without education, his chances of earning a decent wage are nil.

the estate of Los Cerros, going and coming by bicycle. The first year I walked it. I went eleven kilometers on foot each way. Afterward I bought a bicycle, and when that one broke I bought another. Finally I got a small motorcycle—the kind that requires only a permit instead of a license. When I did not earn enough, I had to owe to the store until I could sell a pig, a turkey, or something that we raised, in order to pay the debt. I have owed up to seven, even eight thousand pesetas. In the winter when one earns less, one gets into a trap. In the summer since one earns more, well, then one pays off one's debts.

"A fellow who had just come back from Germany told me about it and how much he earned. The wages were good. I decided to go. In Spain I have so many children. Before we didn't eat half the things we eat now because I didn't earn enough. Since I earn more, my family can buy other things to eat—good meat, fish. If there's a good lettuce—before I couldn't buy it, but today I can."

Pedro's wife, Carmen, says: "If I didn't have so many children, I would go to Germany with my husband. But you can't go with so many children. When Pedro comes back, we will go to Barcelona and I'll stay there. There's more opportunity for the children to find work in the factories and there's more chance for education. I have mixed feelings about going because I was raised here. And my mother is here. She's over seventy. But I'll come back to see her. I have family there, my other in-laws, my husband's family, my cousins."

Once limited to jobs as maids in Spanish towns and cities, some girls now work abroad. This 14-year-old is more fortunate—she helps at home and works in the fields to save for her trousseau.

Directly below the town of Valle are irrigated gardens and citrus groves, and beyond them, running south to the mountains and west to the sea, is the valley floor, once cultivated but now largely untended grazing land for cattle. Before the Civil War, the mountain and agricultural lands of Andalusia were often the center of labor agitation—the fulcrum of the anarchist movement. Today, 33 years after the war, a landowner has no such concerns. There can be no protest. With a few strands of wire, a landowner can fence in his land and forget about the worries of labor, the expenses of contributing to a social security program, the uncertainties of weather, the destructive force of the winds from the straits, the need for investment in seed, nitrates, and weed killer, and the appeals of reformers. With little attention, bulls, cattle, and sheep can be kept for profit, watched over by a few men paid the minimum agricultural wage. Children, old men, and women serve in the place of men for the manual tasks. The absence of workers lends *tranquilidad.*

In 1962, according to the *Primer Censo Agrario de España* of that year, 58.2 percent of the approximately 700,000 hectares of land in the province of Cádiz was made up of 488 estates larger than 300 hectares (one hectare is about two and a half acres). Of these lands, about 100,000 hectares carried nothing more than "spontaneous" growth—clover, weeds, and thistle—and about 150,000 hectares more was forest, a large part of which could have been more productively used. The past ten years have not improved these figures. But there is little incentive for a negligent landowner to invest capital in his land. It is the owner who decides the value and productive potential of the land, and the lower the official classification the land receives, the less tax he is required to pay.

Although Cádiz historically has been a haven for revolutionary ideas—earlier in the century it nurtured a strong anarchist movement that sought to work the land collectively—there are many workers who never seriously considered revolutionary change. According to their view, the responsibility for the normal functioning of the world should be divided among the classes: the landowners organizing labor for the toilers of the soil. In this way, the classes would exchange labor or service for wages or goods. The inequality of profits as compared with wages was considered a misfortune to be endured, for after all, not everyone can be born rich and avoid labor.

But now, even the most conservative are disturbed by the dysfunctioning of the system, for it is clear that the rich have failed to do their duty—to provide work for the poor. To provide work the land must be tilled, and a portion of the profits must go back into the land to improve it. In former days the landless workers of Valle could gather wild asparagus and snails and poach birds during the winter months, running up debts in the local stores while waiting for agricultural activities to resume in the spring. But now, when spring comes, the expected work does not materialize. Folk singers in Valle lament:

This village is becoming
like the capital
with the latest dances
and with the movie house.
Modern TV sets
to distract the workers
so they won't think about anything
that will harm them.
Beloved Spain, where are
your thoughts for the worker?
If the fields are not sown
we will all have to go
to foreign lands.

Even when work is available in the fields, one man's earnings are not sufficient to support a family. In 1971, the average daily wage for an

agricultural field hand in Valle was 150 pesetas (1 peseta equals 1.4 cents). When a kilo of meat costs 150 pesetas, a kilo of the cheapest fish 20 pesetas, a liter of milk 9 pesetas, six eggs 24 pesetas, and a kilo of bread 12 pesetas, 150 pesetas is far from an adequate wage. In addition to the low pay for day labor, these workers are employed only six to seven months of the year. Those laborers who have fixed employment on the estates work regularly, but receive even less money. The poor and the hapless are forced to put their children to work in the fields—or else they must emigrate.

It is with these facts in mind that the present Bishop of Cádiz has continually criticized the rural landlords, "usually persons of a ritualistic or moralizing Christian conscience," as being "insensible to flagrant social violations that are true crimes against justice and common welfare." Denouncing landlords for denying workers elementary rights, he has implored them to correct conditions.

The peasants and workers of Cádiz have always believed that the riches of the country lie in the land, but they also know that the land has been carelessly used. The vast estates, owned by absentee landlords, have never been properly cared for, and the soil shows signs of erosion and neglect. Much of the land is

With the advent of butane gas, this village's main industry, charcoal making, quickly died. Since little agriculture is practiced in this mountain region, men travel far to find work. Today the village streets are quiet.

owned by the descendants of medieval vassals, such as the dukes of Medinaceli and Lerma, whose ancestors received vast tracts after the expulsion of the Moors in 1492. A great deal of this land continues to be rented to others to graze cattle or raise bulls, or is reserved for private hunting preserves.

Today there are other great landlords, rich from land accumulated by their families in the last century, or more newly rich from real estate speculation on the Costa del Sol. These owners use their estates as weekend retreats or accumulate estates only to allow the land to lie fallow. All but a very few of the great estates are haphazardly managed with little expenditure of capital or time. As in the past, the great landowners customarily live far from their estates, perhaps in Madrid or Jerez, and make infrequent, or at most, weekend visits. Some never appear more than once a year; others come only to look over their land once and are never seen again. Their income is derived from other sources to which they pay more heed. If the rains come late, the absentee landlords do not know that the cattle lack feed. Some do not know or care that their cattle perish. Few, if any, hectares are sown with crops, even grass. This would require organization and investment and an increased laboring force. Some estates, reserved or rented as hunting preserves, are stocked with deer or more exotic game. During the year the estate is protected by armed guards to prevent the local people from poaching. Then, on a festive occasion, a party of men and their attendants will journey to the estate and shoot 200 deer in a single day.

The land, of course, brings status. Many landowners maintain vast estates primarily as a sign of caste—raising brave bulls and sporting with them in the pasture on weekends during the long spring and summer, tilting at them with lances from horseback. Or they

work with the cape in a small arena, testing the heifers to see if they have the proper mettle to be used in the breeding of fighting bulls. "In front of the bulls," says one rich devotee of the art, "I think only of the beautiful form I must take." Tired, he stretches out against one of the wooden barricades and indicates which of the young vagabond *muletillas* can have a turn practicing his skills. The ragged boy chosen, eager to become a *novillero*, an aspiring matador, drops like a bird from the small stand and dashes out with his *muleta* to confront the exhausted and confused heifer, which is plastered with sweat, sand, and excrement.

On the unplowed pastures of Andalusia, it takes four to five years for fighting bulls to mature. If beef cattle are adequately fed, only eighteen months are required for them to reach their maximum weight. Since the rules of the bull ring stipulate that a fighting bull be at least four years old, the breeders are not interested in intensive feeding to mature the animals more rapidly, nor, as a consequence, in intensive cultivation. It is not profitable for the breeder to grow feed crops, or to invest in nitrates, improved grasses, or mechanization.

Little has been done about the problem of land reform since the death of the Republic. At present, in the municipality that includes Valle, 48 landowners own 32,007.6 hectares, or 59 percent, of the land (this is almost the same as the situation in 1930 when 41 men owned 42 percent of the land). In the adjacent municipality, 27 owners control 27,128 hectares, or 58 percent, of the land (comparable to 1930 when 64.50 percent of the land was owned by 31 men). In some cases, the same landowners have extensive lands in both municipalities—and in others as well—and many of them are related to each other by blood or by marriage. It is difficult to calculate how much land each owner possesses in total, since each municipality in Spain keeps separate records. In 1932, land records of the Duke of Medinaceli were filed at the request of the Republic, along with the records of other wealthy landowners, and then marked for expropriation. The records showed he owned a total of 79,147 hectares of largely arable but untilled and underexploited land. Time and the present government have little altered those holdings.

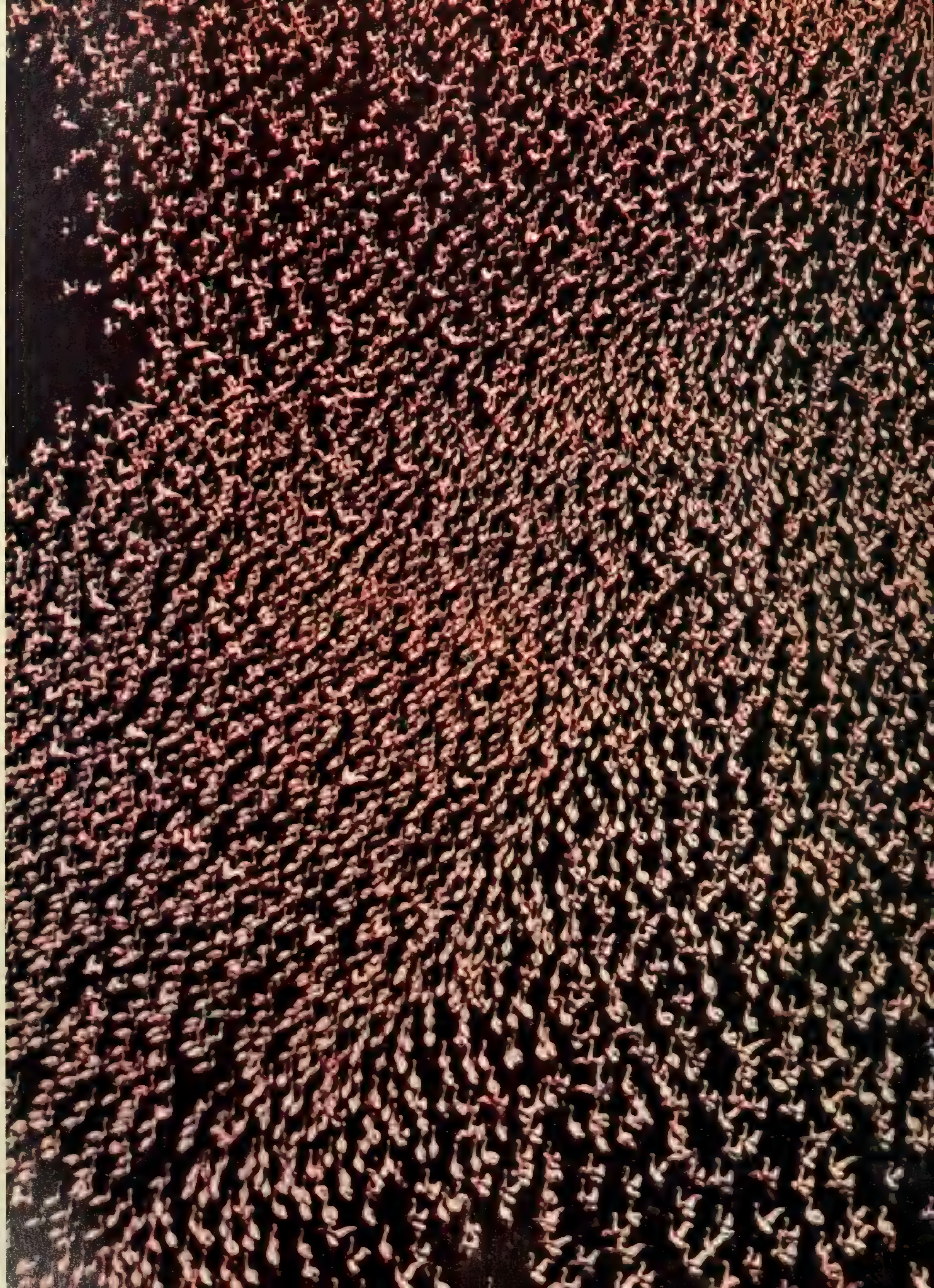
The Civil War ended plans for extensive land reform as well as government and workers' movements toward collective land use. Tourist development, rather than land reform, is the prime concern of the government. With a population of a little more than 33 million, Spain now welcomes more than 20 million tourists a year, who bring in about $1.5 billion. Rather than expropriating the estates of the Duke of Medinaceli, the government is said to be encouraging him to develop a portion of his estate at Castellar near the Mediterranean for tourism or to sell it to a company that would put up tourists hotels and chalets.

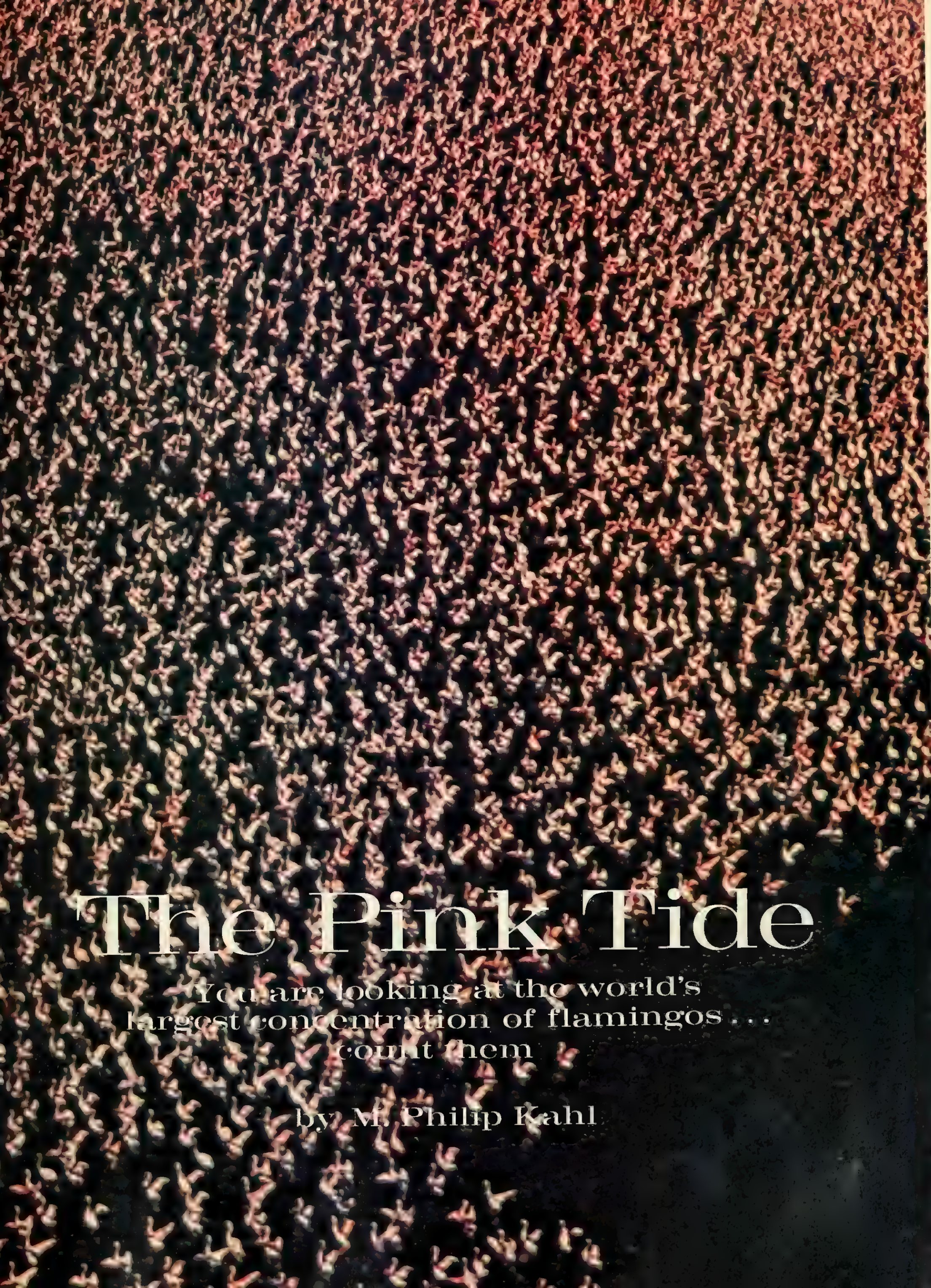
Rather than practice internal reform and work the lands, the government and the landowners have found it more expedient to sell portions of their patrimony to outsiders—to foreign investors and to tourists. The coast of Spain is owned by German, French, Swedish, Dutch, Belgian, and American companies and individuals. An advertisement in the *International Herald Tribune* advises its readers that the last land available on the Atlantic coast is for sale: the address to inquire for information is in Germany. To avoid the problem of social reconstruction or even of imposing an income tax, Spain has found it more expedient simply to swap populations: the landless unemployed Spanish workers and peasants for the cash-carrying investors and tourists.

Pedro sits in the kitchen of his tiny apartment, his hands in his lap. It will soon be time for the bus to leave. His wife shakes her head. Pedro keeps sending the girls out to ask for the time because his watch has just broken. Their son Pepe has not appeared nor has Pedro's father, Diego, and so one of the older girls goes down to her grandfather's house to see if they are there. Suddenly Pepe comes bursting in; his grandfather follows with a heavier step. Pedro rearranges his black cardboard suitcase, which he bought in Germany, and his wife wipes it clean with a cloth. She puts a pot of food and a loaf of bread in a cloth bag for him to eat on the long train ride. This time when Pedro returns to Germany he will be living alone. "I'll take out a bed and have more room. I'm not really alone. There's a young Spanish couple next door; both of them work in a factory. Another Spanish couple upstairs has a baby about a year and a half. She's very nice and he's a good fellow too. She's from Granada and he's from Galicia. He says he will never return to Spain."

Now it is time. Pedro must go to buy his ticket. He kisses each member of the family goodbye. He does not want anyone to accompany him, but his twelve-year-old daughter, Angelita, slips away to wait for him at the bus station. There is a hubbub in the kitchen. Juanito, who is only two, has hit his cousin in the eye and there are tears. Carmen takes him by the hand, and with a motion to indicate that she means business, she brings Juanito to kiss his cousin. Defeated, his nose dripping, Juanito embraces his enemy. There are a dozen children in the room, but Carmen is calm and patient, talking to the children, consoling them, never raising her voice, never getting angry. It is time to leave. Pedro takes his suitcase, embraces his children, his father, his wife. People stop him on the street to shake his hand, to embrace him.

A traditional craft, plaiting rope from palm leaf fiber, provides a subsistence livelihood for an old man of Valle.





The Pink Tide

You are looking at the world's largest concentration of flamingos . . . count them

by M. Philip Kahl

Six million flamingos brighten the waters of some of the world's warmer habitats with a kaleidoscopic display of pinks and reds. Of this number, more than half live in the Rift Valley of eastern Africa. A million or more of these stately birds will sometimes congregate for months on relatively small bodies of water, such as Lake Nakuru in Kenya, banding the shores with cotton candy colors.

Gathered in flocks several miles long and a hundred yards wide, the highly gregarious flamingos are packed together so tightly that they appear to be a solid mass. At first the eye perceives only a mélange of faded scarlet and slices of white in the slowest of motions, creeping across a landscape boiled out by the African climate. The mountain backdrop of grays, browns, and dusty greens heightens the contrast between the teeming life and the harsh environment. As the mass of feathers on stilts moves to the rhythms of feeding and courting imprinted ages ago, individual images of hooked bills and spindly legs flash into view, register for a moment, then meld back into the throng of a million waders.

The practiced eye quickly spots a comparative handful of birds that are larger than the rest. These are the greater flamingos, perhaps 10,000 in number, a species that also breeds in India, Afghanistan, and around the Mediterranean. The smaller and much more numerous birds, stretching on in endless belts, are the lesser flamingos, a species with a more restricted range.

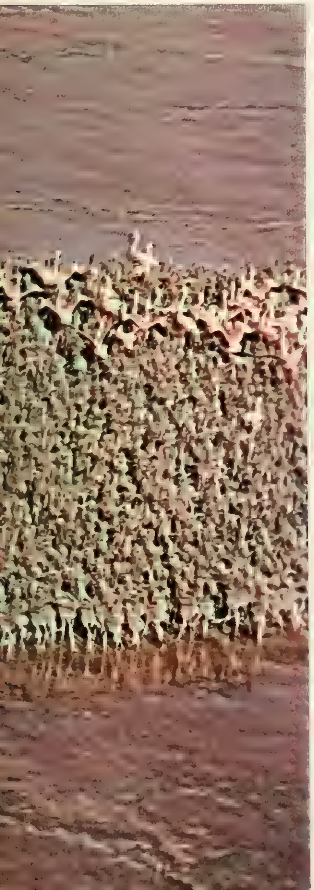
A newly hatched greater flamingo chick undergoes close parental inspection, left. Adults may be able to recognize offspring in the thicket of legs and feather fluffs, upper right, by vocal cues. Chick, right, will remain dependent until able to fly at eleven weeks.

Added to the initial impact is wonderment at how a lake such as Nakuru, only four miles by six miles, can support so many birds. Sampling the water with an ordinary fish net reveals few potential food items. Naturalist Leslie Brown, who has studied African flamingos for nearly two decades, has estimated that a lesser flamingo needs approximately 6½ ounces of food per day, while the greater flamingo requires slightly more. A million birds, then, would consume almost 200 tons of food per day.

How this seemingly limited environment can satisfy such prodigious food requirements is explained by the abundance of microscopic organisms in the fertile waters. Conditions are ideal for the rapid growth of algae: the lake is shallow and frequently stirred by wind, so that each algal cell receives some of the strong equatorial sunlight during the 12-hour day, and water temperature remains moderately high throughout the year. To my knowledge, the precise rates of primary productivity, that is, the creation of plant material by photosynthesis, have not been measured in Lake Nakuru. When they are, I predict that this lake will be found to be one of the most—if not the most—productive ecosystems in the world.

Flamingos are food specialists, superbly adapted by virtue of their strange, bent bills to strain tiny organisms from water. The lesser flamingo lives principally on the blue-green algae and diatoms that abound in the strongly alkaline water, and a large area of the inner surface of its bill is covered with a meshlike network of fine hairs, or lamellae; a series of coarser "excluder" hairs keeps items above a certain size from entering. With this system in operation, the lessers take in and retain organisms between 1/250 and 1/50 of an inch in size. A combined pumping action of the tongue and throat pulls a stream of water through the bill, passing it out again minus the food material, which is retained and swallowed.

Watched over by a few adults and a predatory tawny eagle, thousands of juvenile lesser flamingos form a crèche, on Lake Natron, Tanzania.



Lesser flamingos feed mainly in the upper few inches of water, and because they swim with ease, are able to forage over the surface of the entire lake when the water is calm.

Greater flamingos, however, are primarily carnivores, devouring small zooplankton, such as insect larvae and copepods, from the water and bottom mud. These food items, in turn, live largely on the blue-green algae. Because the greater flamingos crop items from a higher level of the food chain, their food is less abundant than that of the lessers, which feed on plants, at the beginning of the food chain. The greater flamingos themselves are consequently less numerous.

The bill structure of the greater flamingo and its feeding behavior reflect its different diet. A smaller portion of the bill's interior is covered with lamellae, and these hairs are more widely spaced, as are the excluder hairs. The greater flamingo's bill takes in and retains items between about 1/25 and 2/5 of an inch in size. The mechanism does not allow for selection of the kind of food ingested, but this apparently doesn't present a problem for the bird. Because it is primarily a bottom feeder, the greater flamingo is most often found nearer to the shore, where it can reach the muddy substrate either by wading

Spotting a promising feeding site, a greater flamingo will use its dangling legs to ease into a lengthy, not altogether graceful landing.

or by swimming and tipping up like a large pink swan.

Since they normally take different types and sizes of food, the two flamingo species compete little, if at all, with each other and are able to coexist in the same habitat.

For physiological reasons, it is important that the flamingos' feeding techniques efficiently separate food from water before the material is swallowed. Few animals could tolerate the ingestion of much of the highly alkaline lake water, whose pH level is sometimes as high as 11. Part of the problem, at least, must be solved by not ingesting the unwanted material in the first place. The method of filtration feeding, which among adult vertebrates is limited to flamingos and some whales, solves this problem efficiently. It has also been reported that some species of flamingos have nasal glands that

Showing his colors, a lesser flamingo displays in a courtship ritual played out in the shallows of Lake Nakuru, Kenya.

secrete a highly concentrated mineral solution, which may help to remove some of the excessive electrolyte load from their bodies.

Although they feed and live for most of their lives in strong soda lakes, the East African flamingos require—or at least enjoy—freshwater from time to time. Many of the lakes they inhabit have freshwater streams or springs along their shores, where the birds congregate in dense flocks to drink and bathe. The lesser flamingos, possibly because their smaller food items carry a heavier load of alkaline water, seem to require freshwater more often than the greaters. At places such as Lake Hannington, Kenya, the only freshwater available in most seasons comes from boiling hot springs that dot the western shore. Here, flamingos gather to drink water so hot that it apparently hurts their feet, for they dance continually—lifting one foot, then the other—as they quench their thirst.

While large, nonbreeding flocks of flamingos are easily accessible, breeding colonies are, in most cases, extremely difficult to approach. Most of the lesser flamingos in East Africa breed far out on the treacherous mud flats of Lake Natron, in northern Tanzania. Few people have seen them there, and most who have, have done so from airplanes.

Fortunately, greater flamingos nested at Lake Elmenteita during two of the years that I lived at Nakuru. Lying about 10 miles east of Lake Nakuru, as the flamingo flies, Elmenteita was easily reached by Land Rover. With the use of a floating blind constructed on pontoons, I could wade to within a few feet of the nests on the rocky islands near the lake's southwestern shore. Here, literally within spitting distance of hundreds of the truncated mud cone nests, I could sit for hours, observing and photographing the home life of these beautiful birds.

During the hatching period in late May and early June, the colony—which contained between 5,000 and 6,000 nests—was bedlam. Parents constantly departed and arrived from feeding trips to nearby Lake Nakuru, bickered with their neighbors, and tended their single, chalky white egg. After an incubation period of 28 days, hatching began with a seemingly concerned adult standing over each pipped egg, repeatedly bending low to stare at or nudge the opening shell, as if wanting to help in the delivery but not knowing how.

After hatching, the chick stays on or near the nest site for a few days, then begins to wander farther and farther afield between meals. By about ten days of age the various young from a group of nests band together in a sort of crèche, sometimes comprising hundreds or even thousands of young birds. When most of the parents are away from the colony gathering food, the group of young may be attended by only a few "baby-sitting" adults that remain behind.

Parents returning to the colony seem to recognize their offspring amid the milling, ravenous mass of gray chicks. Walking into the group, a parent will select its chick from the others and feed it. Experiments with marked birds and playback recordings of voice are still needed to determine if parents feed *only* their own young and, if so, whether the birds recognize each other by voice, as do penguins, or by some other cue.

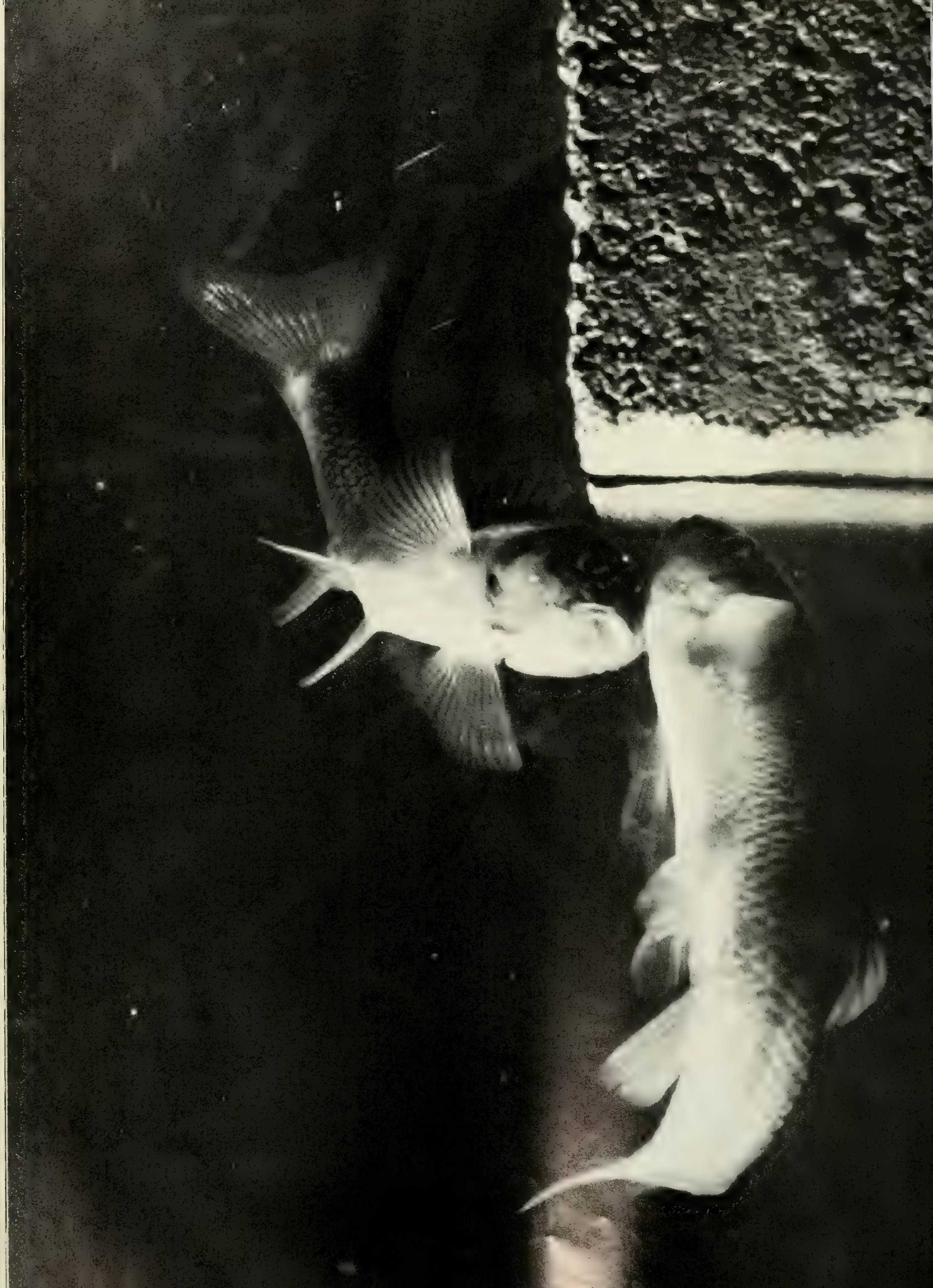
A blood-red fluid that is drooled from the parent's bill provides sustenance for the chicks. Amid the movement of the crowd pressing on all sides, parent and young give and receive food with bills touching for several minutes. Chemical analysis of the fluid has shown that it contains about 1 percent blood and is rich in carbohydrates and fat. Evidence also indicates that this fluid is not composed of regurgitated matter from the adult's stomach, but rather, that it is a secretion from the lining of the throat—akin to the crop milk of pigeons. Its nutritive value is evidenced by the rapid growth of the young flamingos.

Mortality among the eggs and young in nesting colonies is sometimes very high; in some cases, even total. Most common among the reasons for nesting failure are extreme flooding, which inundates the nests, or drought, which leaves them high and dry and causes the adults to desert. Predators, including man, take their toll of eggs and young in some colonies. But pilferage by man for eggs from the nests for food is fortunately not common in Africa.

Once a flamingo learns to fly, it can look forward to a long life. Adults have few natural enemies, and large amounts of stored fat within their bodies allow the birds to survive any of the infrequent food shortages that occur within their habitats.

Being spectacular birds, and posing so many riddles, flamingos have long attracted the attention of biologists. Yet many aspects of their lives remain clouded in mystery. Little is known, for example, of their considerable migratory movements, many of which occur at night. Even the taxonomic classification of the flamingo has not been resolved. While their field habits resemble those of ducks and geese, anatomical evidence suggests a strong relationship to the storks and ibises, and recent egg-white protein studies have demonstrated an affinity with the herons.

Because flamingos live in hostile environments featuring brackish or alkaline water and arid surrounding lands, investigation of their behavior has been difficult. But the environment's hostility is in the eye of man; the splashes of color and raucous sounds of the flamingo testify to the richness of life along the mud-caked shores.



Mating of the Fathead

Males of this common minnow species break out in stripes and sprout dorsal pads and pearl organs as the mating season approaches. Later they will guard the eggs and keep them clean

by Vicky McMillan

To many people a minnow is just a small fish that will someday grow up and be big enough to catch and eat. While studying fathead minnows in a Saskatchewan lake, I often had to explain to passersby that the two- to three-inch-long fish in my buckets would never get much larger or grow into anything else. They were true minnows, members of the family Cyprinidae and a species, *Pimephales promelas,* in their own right.

Minnows such as the fathead are not entirely unappreciated. Valuable as bait and forage fish, fatheads can be easily propagated in artificial ponds. Hardy and prolific, they also survive well in aquariums. Eggs, fry, and adults have been used to study the effects of pollutants on fish. Recently, minnows were used to evaluate the biological effects of material collected from the moon.

Despite their usefulness, however, fathead minnows have been little studied for their own sake. During the past two years I have analyzed the breeding habits of these fish, hoping to expand earlier, sketchy accounts of their behavior. I have encountered no complex displays, no bizarre findings. Compared to such fish as cichlids, the fathead displays rather uncomplicated breeding behavior. Yet for all its apparent simplicity, the life of the fathead minnow involves some intriguing adaptations to a particular reproductive style.

Fathead minnows occur across southern Canada and, in the United States, from Lake Champlain west to the Dakotas and south to Kentucky and the Rio Grande. True to their name, adult males have robust heads, looking, as biologist R. B. Miller once described them, "like goldfish with heavy black socks pulled over their heads." The females' heads, however, are relatively small, pale, and pointed.

Breeding males bear three horizontal rows of white tubercles, or "pearl organs," on their snouts. Additional tubercles may appear on the chin, and some of the pectoral fin rays bear smaller versions of these horny, conical projections. Breeding tubercles are actually seasonal proliferations of the epidermis. In various arrangements they are characteristic of many other species of minnows, and much interest has been aroused concerning their roles in the behavior of these species.

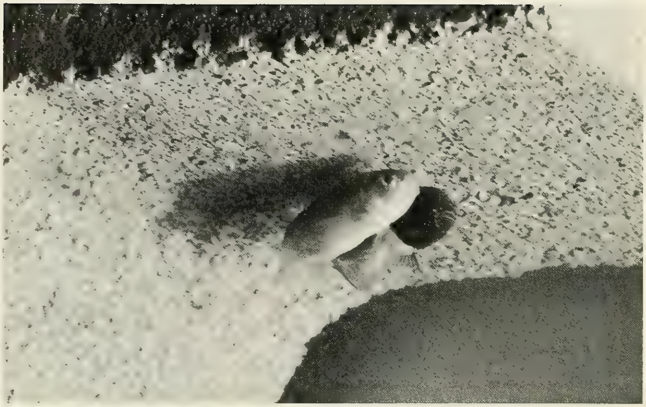
Breeding male fatheads differ markedly from females in two other respects. First, they are often patterned with alternating light and dark vertical bands. This banding, which may appear and disappear in seconds on an individual, occurs particularly in situations involving aggression or sexual activity. While females, too, can become banded, they do so much less frequently and less intensely than males. Sunlight colors the males' stripes deep purple and light tan, and under good field conditions males are easily distinguishable from females.

Secondly, breeding male fatheads possess a peculiar dorsal pad, which extends from the back of the head to the dorsal fin. Like the tubercles, the dorsal pad appears at the start of the breeding season and is later lost. A soft, thick cushion, it is bluish gray when fully developed. For so prominent a structure, it has received surprisingly little attention and remains somewhat of an enigma.

The breeding cycle begins in late spring when males select individual territories beneath floating or submerged objects. A wide variety of opaque materials may be used—anything from lily pads and old tires to stones or pieces of wood. Each male vigorously defends his territory from intruders of either sex. Despite strong attacks, one or more females do eventually succeed in spawning with a male, depositing adhesive eggs on the underside of his territorial object. The male alone remains to defend and care for the developing eggs. Once they hatch, young minnows receive no further care.

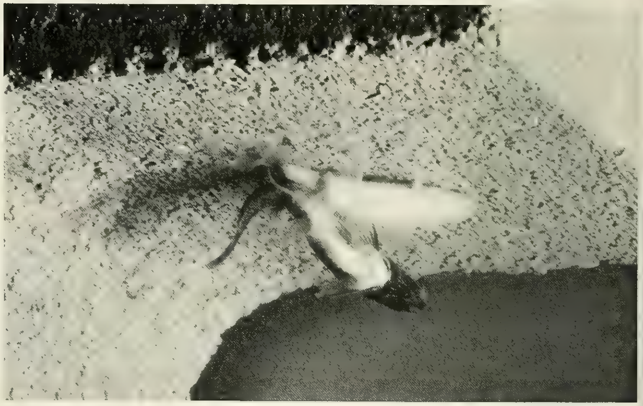
Territoriality, male parental care, and egg deposition on the undersurfaces of objects are not unique to fathead minnows. In fact, fish as a group exhibit a vast array of reproductive styles: internal and external fertilization, egg laying and birth of live young, parental care and complete lack of it, elaborate courtship patterns, and migrations. Still, we expect that in each case behavior patterns will be generally adaptive, of survival value to the species. This expectation was important during my early observations of fathead minnows, when I didn't know what I would find. I soon discovered, not surprisingly, that male fatheads, which play so prominent a part in breeding behavior, are admirably suited to their role.

Pectoral fins spread and mouth agape, a male fathead dives at an intruder that has challenged its possession of a territory.



A female (lighter color) that has braved the threats of a territorial male swims in close lateral contact with him prior to spawning.

A male and female begin to separate after mating. The thick thread curving from the male to the block is probably just-released milt.



A notable feature of males is their tenacity in defending their territories, even against females seeking to spawn. After selecting a site beneath an object, a male generally restricts his movements to that immediate area, and spends most of his time within several inches of the object's undersurface—where eggs will ultimately be deposited in his care.

Males may become so involved in their territorial duties that they can be easily caught by hand. Miller found that when such individuals were removed from their territories, they returned to them from distances as far as fifteen feet.

Generally, territorial defense by an animal operates chiefly or entirely against members of its own species. In fathead minnows, however, aggression is often exhibited toward other species. Males in my aquariums threatened similarly sized fish, such as sticklebacks and spot-tailed minnows, as well as nearby snails. Some even butted the extended fingers of observers. Daniel Isaac, who studied fatheads in Minnesota, reported that males carried leeches away from their territories and that one male vigorously, but unsuccessfully, tried to defend its eggs from a painted turtle.

Since the eggs of fathead minnows are laid on exposed surfaces, where they are exposed to predators, including the fathead itself, this aggressive behavior is highly adaptive. Despite the pugnacity of territory owners, however, out-and-out fights are uncommon. Because males will utilize a wide variety of sites, most natural habitats have sufficient territorial space, and rigorous territorial battles are therefore infrequent. Moreover, male fathead minnows will tolerate the close presence of another male. In a dugout stocked with more than 300 fish, I once found two individually guarded egg masses about six inches apart on the underside of the same floating board. Their owners accepted each other, yet chased off all other fish venturing near their respective territories.

The fathead minnow, unlike such species as the spectacular Siamese fighting fish, does not possess elaborate displays. Noncontact aggression is relatively simple. Most such interactions I witnessed in the field were brief: a male charged or chased another fish and the intruder quickly fled. In other encounters, a territory owner responded by tail beating, undulating the posterior part of his body so that a current of water was forced against the intruder. Tail beating probably serves an intimidatory function, operating through the lateral-line sensory system of the threatened fish.

In the laboratory, more rigorous battles can be staged between males. The procedure is simple. First, males are isolated from one another, one per tank. Each tank contains an eight-inch concrete block shaped like a C, which the male readily adopts as a territorial object, spending most of his time close to the underside of the top of the C. Once individual territories

are established, a male is removed from his own block and placed in another male's tank. Generally the intruder attempts to occupy the new block as if it were his own, and vigorous fighting between owner and intruder often ensues.

Such fights involve a number of behavioral components that, in similar forms, occur in other fish species as well. The two males may carrousel, or circle head to tail, as each tries to attack or dodge attack. They may engage in mutual snout-butting contests, in which they use their rows of pointed tubercles to advantage. And tail beating may become intense, involving actual contact between the two fish.

During early observations of territorial males, I frequently wondered how females ever succeeded in spawning with them. There was no elaborate courtship—the males stayed on their sites and seemed to drive away ripe-looking females as readily as they did other males. With time, I found that initial pair formation depends largely on the female—she has to be highly motivated sexually and persistent in her approaches to a male despite his attacks. Still not clear, however, is the extent to which the territorial object itself, the bright banding of the male, and the male's vigorous movements on his site all attract prospective females.

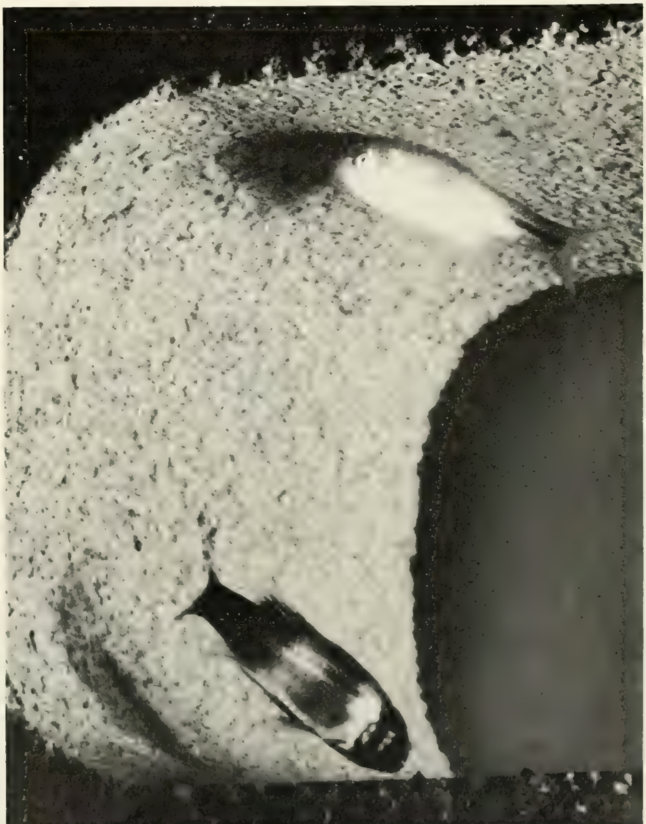
Spawning itself does not occur until a male and female achieve close lateral contact. When their bodies are pressed side to side, the fish begin to vibrate. Portions of their dorsal surfaces touch the underside of the territorial object. The pair may vibrate rapidly in one spot for several seconds before spawning or, more commonly, they may move in a generally circular course below the object. Here the fish are highly uncoordinated—one may move faster than the other; often the pair stop, start again, change direction.

Finally, when a sufficient degree of vibratory stimulation has been reached, the male lifts and presses the female's ventral surface against the object's underside. In doing so, he turns so that he is beneath the female and can use the posterior part of his body to manipulate her upward. The tubercles on his large pectoral fins also help him grip the female tightly. As the fish's bodies are taut and strained in this position, the female emits one or perhaps several eggs, and the male probably releases sperm at this instant. Then the pair abruptly separate, although a new bout of vibrating may begin only seconds later.

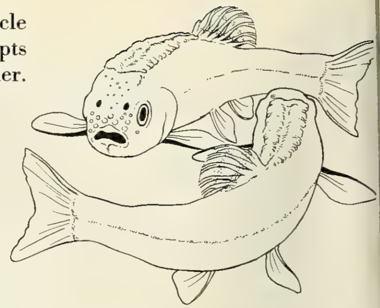
As the fish spawn, some eggs fall to the bottom, but most adhere to the underside of the object. Once spawning is completed the male chases the female from the eggs. During their period of development, which lasts about five days, the eggs are rigorously guarded by the male, although he may spawn again before the first batch hatches.

During egg care a male exhibits striking behavior. Assuming a vertical or near-vertical position, he "nibbles" at the egg mass, contacting it with his lips and snout. Nibbling appears to be necessary to keep the eggs healthy. Fungus-infected or otherwise "bad" eggs are eaten, protecting the rest of the batch from infection. When males in aquariums are removed from their eggs, fungus can spread rapidly through the batches, prevent-

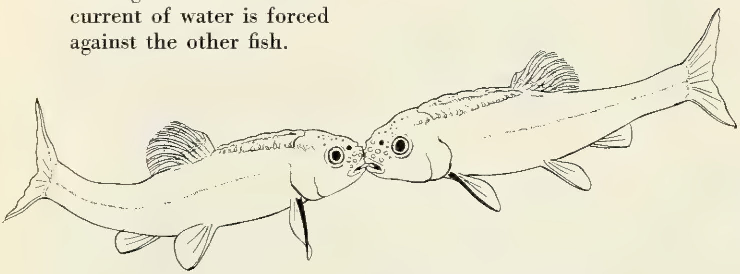
Male and female, separate here, may spawn again in a few seconds. A layer of eggs accumulates on the ceiling after a series of such bouts.



Carrouseling fish circle head to tail in their attempts to touch each other.



The aggressor at right is beating its tail so that a current of water is forced against the other fish.



The pearl organs that grow on breeding males give them protection during snout-butting contests.

ing some or even all of the eggs from hatching.

A parental male also moves in a circular path, or in parts of circles, just below the egg mass. During this circling the male rubs his dorsal pad vigorously against the eggs, and the top of his head and the dorsal fin may also make contact. One zoologist has suggested that rubbing with the dorsal pad turns the eggs over and over, allowing a free access of oxygen to all sides. My own observations lead me to doubt that such movement is possible.

I do agree, however, with other theories about the pad's function. The male's vigorous motions while circling—and nibbling—must certainly agitate the water around the eggs, aiding aeration. This effect would be particularly important in the slow, stagnant waters that many fathead minnows occupy.

Furthermore, dorsal pad contacts and nibbling probably remove snails, aquatic insects, and other animals from the vicinity of the eggs and keep the eggs clean. They may even facilitate hatching. When a male is removed from the tank in which his eggs are hatching, many of the fry protrude at length from the egg mass. It may take as long as fifteen minutes for some to break free. If the male is returned to his eggs, his vigorous contact movements quickly sweep the protruding fry clear of the eggs, flinging them far from the male himself. This is advantageous since males—in aquariums, at least—will eat their young.

Rubbing and nibbling are not confined to the parental period. In fact, they are performed by a male during his entire residence within a territory—eggs or no eggs. Quantitative studies, however, show that such behavior occurs much more frequently when a male is tending eggs. Clearly, spawning or the presence of eggs or both contribute to this change in behavior.

What causes nibbling and dorsal pad contacts even in the absence of eggs is still unclear. Perhaps this behavior is involved with a high degree of parental motivation. Perhaps it occurs as a general response to a selected object, and can thus be regarded fundamentally as "territory-directed" behavior. At any rate, in their preparental context nibbling and rubbing must help to keep the future spawning surface clean.

Furthermore, during both eggless and egg-tending periods, nibbling and dorsal pad contacts have other roles in addition to their parental ones. In fact, they might be termed truly multifunctional, since in different contexts they produce different effects. This point is highly interesting ethologically, since it suggests an economical use of behavior—a particular action can play more than one adaptive role.

To illustrate this point, I can cite some pertinent observations. Fighting between a territory owner and an intruder generally becomes most intense if the intruder nears the underside of the contested object and especially if he touches the object. A highly aggressive intruder will try to do just this—to nibble the object and rub it with his dorsal pad. In other words, he will try to perform actions typically performed by males who have already chosen and established themselves in territories. Interestingly, the owner of the object also contacts it during the territorial dispute, so that intense fighting alternates with attempts by both fish to rub with their dorsal pads and nibble.

These and other observations

suggest that nibbling and dorsal pad movements can act as aggressive or territorial displays, signaling a male's ownership of a site and his readiness to defend it.

They may have sexual functions as well. When a male is attacking a female seeking to spawn, he often interrupts his attacks to vigorously contact the object with his dorsal pad. Dorsal pad contacts in this context may function as a subtle attractant to ripe females.

Collectively with morphological features—the tubercles, vivid banding, and dorsal pads of males—nibbling and rubbing are striking adaptations to a mode of reproduction in which the male plays the predominant parental role. Many more links need to be established, however, between behavior and structure in the fathead minnow. Cell analysis by R. J. F. Smith at the University of Saskatchewan may shed additional light on the significance of the dorsal pad. Intriguing questions remain: Of what types of tissue is the pad composed? How is its growth governed by internal changes in a male as the breeding season approaches? Does the pad possess special sensory receptors that give a male information about his territorial object and his eggs?

Such questions will probably be approached largely through laboratory studies. Further field work is also essential, however, because it is only by observing the fish in their natural surroundings that the adaptiveness of their behavior can be fully appreciated.

Often, instead of conscientiously taking notes, I have sat motionless on a lakeshore, caught up in the activities of minnows breeding only a few feet away. Males were continually on the move, darting pugnaciously at intruders and vigorously rubbing their eggs, while sunlight glinted off their vividly banded bodies. The life of each male fathead centers around his own small territory and eggs. Every year, minnows perform the tasks that, in a long evolutionary process, have become a trademark of the species. For all animals—including man—there is the perpetual threat of extinction, but the fathead seems better equipped than we are to face the demands of our environment. What resources it utilizes will puzzle scientists for some time to come. ■

 Continued from page 19

tolerance of the residents. One Long Boat Key resident fed an average of 400 pounds of dog meal a month to raccoons visiting his restaurant. While most members of the community tolerated the raccoons as friendly nuisances, many individuals considered them community pets.

"If one understands the 'domesticated' status of this animal population, the emotional response that the rabies outbreak elicited from the community is quite understandable. Rabies control measures, the investigations of the epizootic, and even the existence of a rabies outbreak in the raccoons became controversial. One of the larger newspapers in the area took a special interest and began to report provocative and often misleading accounts of the 'raccoon killing.' A lead editorial lectured on the ecology of the situation based on the assumption that the 10 percent prevalence of rabies in the raccoons was 'about normal for any wildlife population' and darkly predicted a plague of rats and rattlesnakes following the loss of the raccoon population. Feature stories lamented the loss of the animals to medical research and questioned the motives of the health department officials concerned."

The local epidemic on Long Boat Key eventually burned itself out, as rabies itself reduced the raccoon population. However, the Florida–Georgia epidemic continues and, while the residents of the key were spared human exposures, other communities may not be so fortunate. Certainly Trail Town wasn't.

While raccoon rabies has expanded in southeastern United States, rabies outbreaks in other species have occurred in parts of the United States and the world. Tennessee recorded 34 cases of animal rabies in January, 1972—up almost 300 percent from the previous year. Half of the cases were in foxes. Dr. Eugene Fowinkle, health commissioner of Tennessee, reported that the rabies situation has reached a crisis and "people are literally afraid to walk outside their homes—foxes are coming to doorsteps, or car doors, to children playing outdoors." Fox population control is currently under way in parts of Tennessee.

Skunk rabies was reported a decade ago, principally in Texas, central California, and the upper Midwest. During the 1960s a gradual expansion in all directions occurred, stopping only temporarily at the continental divide in the mountain states. Today, skunk rabies is reported from 60 percent of the states. On March 9 and 10, 1971, a two-county area of north–central Oklahoma was placed under rabies quarantine. The Oklahoma State Health Department reported 56 cases of animal rabies (primarily skunk) for January and February, 1971, compared to 7 cases in the same period during 1970—an 800 percent increase. Reports indicate that intensified efforts in recent years to eliminate predators such as bobcats and coyotes have resulted in an unusually large skunk population in that region.

In 1939 there was an outbreak of rabies in Poland. The virus established itself in the wild fox population, then spread westward at the rate of about 24 miles per year. By 1950 it crossed the Elbe; by 1960 it reached the Rhine. By 1966 at least 26,000 Europeans were receiving postexposure rabies prophylaxis yearly. In 1968 the disease was reported from France, and today it is a major health problem in much of western Europe.

The skunk and raccoon epidemics in the United States indicate a shift in wildlife hosts over the last ten years. Formerly the fox was the major wildlife carrier of rabies, but now the skunk predominates. At present, about 50 percent of the known wildlife rabies is in skunks and 25 per cent in foxes. In addition, bats have emerged as a wildlife rabies host.

The first case of bat rabies in the United States was reported from Florida in 1953, and by the end of 1965 rabid bats were found in all states except Rhode Island, Hawaii, and Alaska. Undoubtedly this rapid expansion is due in part to increased awareness of the problem. There are about forty species of bats in the continental United States; more than half of them have been reported rabid. The bat problem is not limited to rural areas. Last year 43 bats were turned in to the New York City Department of Health, and two of them were rabid.

Only this post and sign remain of a kennel Melvin Barton built in 1970. When one dog became rabid, he disposed of them all.

Trail Town is a cluster of trailers, small houses, a gas station, and a junkyard surrounded by swamp. Its inhabitants include 60 dogs.

Most bat-associated human rabies, including the case of a New Jersey man who died from a bite on the lip last November, results from the direct bites of infected bats. This fits into the general method for transmission of the disease, that is, in virus-laden saliva from animal to animal. However, in 1956 and again in 1959, two humans who died from bat-transmitted rabies had no history of being bitten. The first was a Texas scientist who had been working in a cave on a bat rabies research project. The second, also in Texas, was a mining engineer who spent some time in a cave on a prospecting assignment for a bat guano mining company.

In 1962 the existence of airborne transmission of rabies to animals was proved in Frio Cave near Uvalde, Texas. A number of animals, including twelve foxes and ten coyotes, were caged within the bat cave for four weeks. The cages were constructed so that neither animal nor arthropod could enter them. All of the coyotes and foxes became ill and died of rabies. Since that time, spelunkers have been advised to take the pre-exposure rabies vaccination.

In Mexico and many of the Central and South American countries, the vampire bat is an extremely serious vector of disease. Rabies from this bat is considered to be the most frequent cause of cattle death. During 1956 an estimated one million cattle died due to vampire rabies, for an economic loss of about $80 million.

Although rabies was commonly believed to be a quickly fatal disease, it was shown as early as 1936 that rabid bats can live for a long time. Yet dogs or men almost never survive rabies. Two explanations, both apparently correct, arise for these phenomena: first, there are slightly different strains of rabies virus existing within different species of infected animals; and second, certain individuals within a species, or even certain species, are latent carriers, that is, they are infected with rabies but not diseased.

In a series of laboratory experiments, groups of mice were injected with rabies viruses from dogs, vampire bats, and skunks. While all the mice developed rabies, the course of the disease was different with the virus from each animal. Incubation periods varied; the impact on the brains was different; and the virus from the skunk was not always fatal. These results indicate that different strains of rabies virus exist.

Two distinct types of rabies infection seem to occur, depending on the species of animal and the strain of virus. Various wild animals, including certain bats and skunks, get subclinical infections; man and his domestic animals, along with certain other wildlife species, are affected by encephalytic infections.

Any parasite that consistently killed all of its hosts would doom itself to a brief course as a viable species. A successful parasite, including the rabies virus, needs the ability to infect its permanent host without causing fatal disease. Thus the parasite insures itself of an undisturbed environment for survival. If animals within a species consistently die as a result of a specific infection, then that species does not represent the natural, permanent host, but rather an unnatural, or aberrant, host. Dogs and man, for example, are aberrant hosts of rabies. Conversely, if you find a species that only sporadically dies from a specific infection, presumably it is a natural host.

Sporadic cases of rabies occur in the United States in the spotted skunk and the long-tailed weasel, thus incriminating them as natural hosts. Mongooses in Asia, and the civet and the polecat in South Africa, have also been identified as rabid in areas where the disease is otherwise unknown. These hosts maintain the rabies virus between epidemics.

When present in an animal, but not causing disease, the rabies virus

is found in the mucous-secreting glands of the respiratory tract. The virus has an affinity for glandular tissue, often invading the pancreas, and has been recovered from the milk of a rabid vampire bat. The virus causes disease only when it invades the nervous system.

Wildlife rabies is an extremely complicated problem, and man directly worsens the situation in several ways. Alteration of an animal's basic life pattern can either activate a latent rabies infection or lead to a new infection. Animals, like men, are more susceptible to disease when under stress. Rabies virus changes, the severity of the disease increases, and the susceptibility to the infection rises under conditions of overcrowding, nutritional deficiency, and concurrent disease.

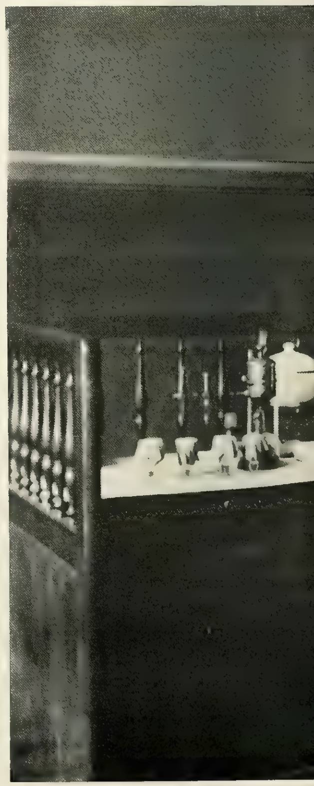
Working with experimental animals, O. A. Soave showed in 1961 that reactivation of rabies virus infection can occur with the administration of adrenocortical hormones. In 1964 he demonstrated reactivation of rabies virus in guinea pigs due to the stress of crowding. Presumably this was related to the circulation of high levels of steroids in response to the stress.

Taking this concept out of the laboratory and into the field, it is possible to correlate the rabies outbreak with the crowding of raccoons on Long Boat Key. As the land suitable for them was bulldozed and developed, the animals were crowded together. Fed and protected by the residents, the raccoon population was further crowded by an unnatural increase in population. Under these stressful conditions the island colony became highly susceptible to disease. And with a rabies epidemic on the nearby Florida mainland, the dangerous outbreak on Long Boat Key was almost inevitable.

Man's effect on the environment has historically been only local in scope and cannot account for the worldwide spread of rabies. But the massive intrusion of man in natural cycles is creating a global impact. As man encroaches, both directly and indirectly, on the habitat, he introduces environmental insults that animal populations cannot tolerate. The killing of predators resulting in the growth of the skunk population—and the subsequent rabies epidemic—in Oklahoma is an example of this concept.

Man also worsens the situation by shipping rabid animals interstate or internationally. Wild animal farms in Florida ship thousands of adult raccoons, trapped in endemic rabies areas, to points all over the United States. The raccoons are usually released back into the wild by gun clubs for use in training hunting dogs. There have been documented cases of the transfer of infected animals, but no action has been taken to insure that only healthy animals are sold.

People often buy wild animals as pets—skunks, exotic cats, and raccoons being especially popular. Dr. Michael Hattwick, in a case study accepted for publication in the *American Journal of Public Health,* traced one rabid pet skunk that bit its owner in Seattle, Washington, back through pet shops and wholesalers to the area of Oregon where it had been caught as a weanling. The skunk was one of 69



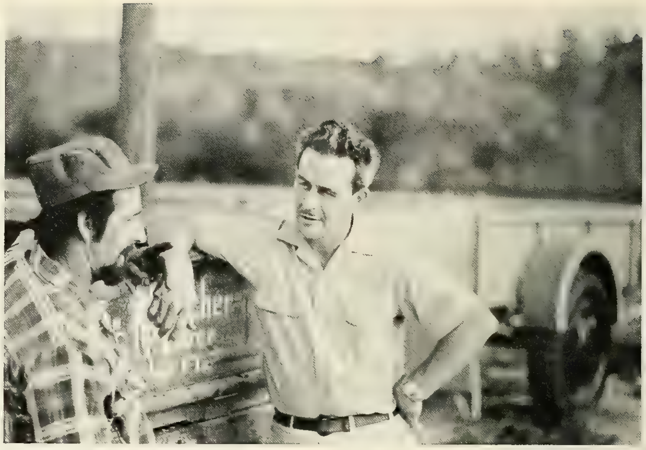
in a shipment. Skunks in the lot mixed freely so that all were exposed to rabies. Over all, through the shipping and handling procedures and in the homes of owners, 366 persons had been exposed to the skunks and 80 of them had been bitten.

Hattwick reports further that approximately 180 skunks are introduced annually into the Portland, Oregon, area, which has a human population of 382,000. By extrapolation, it can be calculated that at least 100,000 Americans are bitten each year by pet skunks. The nature of the wild animal pet business being what it is, many, if not most, of these skunks come from endemic rabies areas and are shipped without the benefit of any health examination.

In New York City, in addition to the 37,488 dog-bite cases last year, there were nearly 100 reported incidents of what the city health department calls "exotic animal" bites. These exotic animals were mainly monkeys, raccoons, and skunks, as well as a fox, a coati mundi, and an agouti. In previous years bites involved pottos, weasels, ocelots, a leopard, chimpanzees, mink, a margay, and kinkajous. All of these animals are potential rabies carriers.

To prevent rabies, control programs must be aimed at the three hosts involved: man, domestic animals, and wildlife. In man, the disease can be most easily controlled by eliminating exposure to rabid animals. People should be aware of the dangers in handling animals, especially wild ones, whose history is unknown. Responsible ownership,

At the Pasteur Institute, 1905, a man bitten by a rabid dog is given a painful injection. Treatment now is easier and safer.



Strickland, left, chats with Melvin Barton, owner of the rabid dog Drum. By the time he escaped, "in essence, Drum was dead, existing now only to serve the virus."

including vaccination of pets and abstinence from owning wild animals, significantly reduces the risk.

In addition to the vaccination and control of pets, the treatment of livestock should be considered. It is not economically feasible to vaccinate all livestock, but owners of valuable livestock in endemic rabies areas should consider it.

The control of wild animal rabies remains difficult. The only method used on a large scale has been the selective reduction of the population of the species involved. The principle is to reduce the contact rate between infected and susceptible animals. There have been a few instances of success, but more often this method has failed. Some states have operated programs for several years with little or no significant decline in the incidence of rabies.

Many poisoning and gassing procedures are not selective. In Denmark the gassing of fox dens has been shown to exterminate the innocent badger more effectively than the fox, since the badger does not make up population losses as efficiently. In regions of the United States, the black-footed ferret was exterminated by poison put out for other animals.

Any thought of controlling rabies in bats boggles the imagination. However, bats should be kept out of houses where people might come in contact with them. Children should be warned against chasing any bat seen flying during the day, as this is abnormal behavior and may be a sign of rabies infection. Any bat involved in a biting incident should be considered rabid until laboratory examination indicates otherwise.

New methods of wild animal vaccination through medicated bait offer some hope of future rabies control. Further understanding of the ecology and natural history of wildlife rabies may open new avenues of control. But at present, as the worldwide rabies epidemic continues, the dangers for man are great, and incidents, such as the one at Trail Town, will continue to occur.

On March 3, Larry Strickland and David Smart began antirabies prophylaxis. Untreated, each man stood about a 40 percent chance of getting the disease and almost certainly dying. Because therapy was begun within 24 hours of the bite, their chances of getting rabies are less than one in ten.

The puncture wounds on Larry Strickland's leg have healed. Both men have finished the daily, painful series of shots and now wait out the long incubation period, playing the percentages. If signs of rabies have not developed by May 31, most experts would consider them out of danger and the case closed. ■

The Greening of Doctor Hogue

Continued from page 47

saw four of them, and what a sight: the light is so bright that it actually lights up the leaves beside the beetle as it flies. It's a streak of light, it's the Fourth of July; it's really bright, a greenish fluorescent light, an uncanny light I've never seen before. I wonder if my flashlight is attracting them. I'm going to take my flashlight and flash it around in the forest to see if I can stimulate some of these beetles to flash. Oh, there's one, a bright spot of light sitting on a plant only twenty feet from me. It's gradually fading out. It has come on again; now it's fading out again. The beetle is obviously resting on the plant, throwing its light and then letting it fade out. There's another off to my left and another and another. The stars have fallen into the forest among the leaves of the trees.

I'm flashing my light. As I flash it around through the understory of the forest, I seem to stimulate the beetles into glowing. When they go through the air, it's sheer pyrotechnics. Now I'm going to flash my light up into the canopy. There don't seem to be any up there. I'm going to sweep it around the understory again. Ah, as soon as my light comes near a beetle, on comes his light, just like the reflector you see alongside a road when you're driving in a car in the dark of the night. Every time I turn around there's some other unbelievable thing to see. There are two of them now where there was one before. It's like coming out and looking at the horizon on a clear night, and seeing the stars gradually coming into view as the sun goes down and the sky darkens. There seems to be just the right quantity of light coming from my flashlight to ignite these *Pyrophorus.* Oh, my God. There's one that was bright, bright orange, like a falling star or a burning match or a sparkler thrown through the air. One could easily use these beetles to live by, to read by. They're like meteorites falling through the forest. This is a sight I can hardly believe; I shine my light on the tree and it lights up like a Christmas tree. Absolutely incredible. I say my name, Charley Hogue. The night is real, it is real, and I don't know what to do, I am so bedazzled. ■

Seeing is Believing
Continued from page 12

of the world." In contrast, Robert Redfield, by defining world-view as "the way a people characteristically look outward upon the universe," suggested that man was a more active participant. In any case, whether man passively accepts a culturally determined world-view or actively creates a world-view system, the visual bias in the very search by anthropologists for world-view is evident.

It has been observed that for Americans the universe is essentially something they can draw a picture or diagram of. But surely a person's world is felt, smelled, tasted, and heard as well. This propensity for visual metaphorical categories may produce distortion in attempts to describe facets of American culture. It is unlikely that such distortion would even be noticed, since the distortion, like beauty, is strictly in the subjective eye of the beholder. But what happens when Americans or American scientists seek to describe features of other cultures or the features of the natural world?

It is at least possible that by looking for the world-view of other peoples, we run the risk of imposing our own rank-ordering of the senses upon data that may not be perceived in the same way by the people whose cultures are being described. If we are truly interested in understanding how other peoples perceive reality, we must recognize their cognitive categories and try to escape the confines of our own.

The history of man is full of instances of one group's conscious or unconscious attempts to impose its particular set of cognitive categories upon another group. The imposing group typically claims that its categories represent the true nature of reality (as opposed to the categories of the victimized group, which are deemed odd at best and false at worst). Whether it is nineteenth-century American linguists searching in vain for Latin cases (for example, the dative or accusative) in American Indian languages, or a modern Western physician, imbued with the number three, trying to persuade an American Indian, who believes in the sacredness of the number four, that only three doses

or inoculations are sufficient (as in a series of three polio shots), the issue is the same.

This is why it is essential for Americans (and for other peoples as well) to become aware of their dependence upon cognitive categories such as the visual metaphorical mode I have been talking about. Armed with this awareness, it is possible to appreciate more fully the aptness of the visual metaphor Ruth Benedict used to explain why so many social theorists failed to notice custom or culture: "We do not see the lens through which we look." A conscious recognition of our visual bias may help make the lens visible. We must never forget the possible relativity of our own sensory perception categories.

Inventories of the same or similar sense categories found in other cultures may help. Clifford Geertz reports, for example, that the Javanese have five senses (seeing, hearing, *talking*, smelling, and feeling), which do not coincide exactly with our five. The delineation of such differences may teach us just how culture-bound or culture-specific our own observations of nature may be. We tend to delude ourselves into thinking we are studying the nature of nature, foolishly forgetting that we cannot observe raw or pure nature. We can perceive nature only through the mediation of culture, with its panoply of culturally relative cognitive categories.

Much of the study of "natural history" often turns out to be "cultural history" in disguise. Theories and ideas about the natural world are invariably couched in terms of a specific human language and are based upon data obtained from human observation. With human observation expressed in human language, one simply cannot avoid cultural bias. Searching for culture-free descriptions of nature may be a worthwhile goal, and perhaps man will one day succeed in achieving it. In the meantime, we must be wary of mistaking relatives for absolutes, of mistaking culture for nature. Cross-cultural comparisons of sense categories may not only reveal critical differences in the specific senses, but also whether or not the apparent priority of vision over the other senses is a human universal. For the moment, we can do little more than wait and *see*. ■

The End of Ede

MATO GROSSO, by Anthony Smith. *E.P. Dutton & Co., $17.50; 288 pp., illus.*

This book is both a delight and a frustration. It is a visual delight because its incomparable color photographs convey directl to the reader's senses the essence o natural beauty and wonder to b found in the heartland of Brazil. I is frustrating because it documents through a somewhat ethnocentri

by Kempton E. Webb

point of view, the rich natural setting of a Garden of Eden in the process of being dismantled and reshaped by "progress."

The volume is a product of the 1960s, which, in retrospect, proved to be a decade of crucial significance to the vast backlands of west–central (Goiás and Mato Grosso states) and northern Brazil (essentially the Amazon Basin). It was during the 1960s that Brazil occupied and took charge of its remaining wildernesses. In April, 1960, the capital of the country was moved from coastal Rio de Janeiro to Brasília in the heart of the country. Within three years the first all-weather road, the Belém–Brasília Highway, linked the population core of eastern and southern Brazil with the Amazon Basin.

In June, 1966, the Symposium on Amazon Biota was held in Belém in the state of Pará. This remarkable conference gathered several hundred scientists and researchers in the natural and social sciences from all over Brazil and abroad for an exchange of scholarly papers. When they were eventually published, they sounded the death knell for the myth that the vast Amazon Basin remains a *terra incognita*, an unknown land. The latest development has been the plan to build a Trans-Amazon Highway, from northeast Brazil westward to the westernmost corner of Brazil.

This book on the Mato Grosso is but one chapter in the decade-long story of a last rush to know and understand the economic and demographic "zero" of west–central Brazil, and to record for posterity something of its natural, undisturbed beauty before the imminent onrush of civilization transforms the area into but another part of the productive base of the nation.

In the mid-1960s a highway was planned to extend from Xavantina, about 250 miles west-northwest of Brasília, to Cachimbo, just north of the southern border of Pará State. In 1965 the Brazilian government, realizing that there was an unusual opportunity for scientific work to be carried out as the road was being carved through the region, invited scientists to come and explore the area before its forests fell under the ax of the pioneer settler.

The scientific investigation would be facilitated within hundreds of square miles of "virgin territory" by the presence of the new road, over which supplies could be brought in, easing the logistical challenge of providing food, fuel, and supplies, at least as far as the roadhead.

Great Britain received an invitation by way of the British Embassy in Brazil, and forwarded it to the Royal Geographical Society in London. The Royal Society also collaborated. Its expeditions committee pointed out that the road was cutting through "one of the remaining areas of the world which has not been available for scientific research, and which offers opportunities for original research not available elsewhere." The two societies sent a reconnaissance party to Brazil in May, 1966; after six weeks they returned full of enthusiasm and with plans for mounting a major effort involving dozens of researchers from various disciplines—geography, earth science, botany, zoology, medicine.

The expedition's primary objective would be to make scientific observations and to record details of

The Kuarup festival marks end of the mourning period. Men blow sacred flutes and young girls are released after months of seclusion.

both the environment and its inhabitants. From 1967 to 1969, individual members of the expedition spent from one to eighteen months in the field, and it will be perhaps several years before the full impact of their scientific findings is felt.

This book, by the expedition's "science correspondent," is essentially a British perception of a tropical part of Brazil (there were 44 British and 20 Brazilian members of the expedition); the initial impression received from *Mato Grosso* is that of an overly romantic view of a tropical Garden of Eden as observed by those whose normal habitat lies in the higher middle latitudes. To someone who has lived and worked in different parts of Brazil, the perception aspect is particularly fascinating. It is ironic that the highly trained researchers who came from across the Atlantic to delve into the mysteries of the Mato Grosso forests were, by and large, ignorant of Brazil and Brazilians. The account conveys an attitude of fascination with something that is exotic and not quite part of the real world. To Brazilians, of course, Mato Grosso is simply another state within the republic, one that is undergoing a normal and expected valorization and transformation from unused backlands to productive cattle lands. The conservationist biases of most of the scientists were not shared, and could not be expected to be shared, by Brazilians who have waited long enough to experience what the development process means.

Upon confronting the trackless density of the Mato Grosso forest, the naturalists reacted with wonder and delight to all of the new and varied life forms. To the Brazilian *caboclo*, or "settler," there is nothing there. To the Indian inhabitants, however, who number between 60.000 and 100.000 in all Brazil, the forest has everything. They say, "It supplies all our needs: food to eat, timber and thatch for houses, wood for bows and arrows, fruit and medicine." Again, a matter of perception.

Smith's account is probably weakest when it describes people and the wide range of racial and cultural characteristics that make up the Brazilian people. Some statements raise more questions than they resolve. For example, on page

83. "The *caboclo* of Central Brazil is someone about whom it is both easy and impossible to generalize. Racially, and therefore facially, he can be from white to black with his genetic background being similarly complex. Whether mainly Negro or mainly Indian or mainly Portuguese he can be a unique blend, with perhaps Negro hair and Indian features or the other way about." These statements, as well as some others, remind me of the topic sentence written by an underachieving undergraduate student in an anthropology class in an upstate institution: "The Mayas are a queer people." One of the book's annoyances is that the writer conveys too much of a "Gee, here we are among all of these exotic people" impression without providing the reader with sufficient background for understanding what is so handsomely portrayed in the photographs.

There is, of course, a lot known about Mato Grosso and the Indians who live there. Most of the best writings are in Portuguese and are therefore not accessible to most Americans. It seems, however, that the Indians and their problems are worthy of a more understanding and enlightening treatment than they are given in some chapters.

Descriptions of vegetation types, ranging from the different forest densities through the *campo cerrado* to the open grassland *campos* are accurate. The author spends considerable time describing the incredible diversity of insect life. Apparently, the ruling triumvirate on the ground (lest you sit down!) is composed of the ant, the termite, and the tick. This information supports the conclusions of Ellen Bromfield Geld (daughter of the original conservationist and land restorer Louis Bromfield), who calls insects the main challenge to Brazilian agriculture.

There are minor errors that cause one to question other statements in the book. For example, a photograph on page 67 showing a planked rowboat with an outboard motor is described in the text as a "dugout canoe." On page 58 there is a statement that the capital city of Goiás State, Goiânia, has "close on a million people." In 1970 the estimated population for Goiânia was 133,000 people. Later, someone is described as always enjoying

a glass of rum, but that he would not drink *cachaca* since he regarded it as "gut-rot." Actually both rum and *cachaca* are derivatives of sugar cane refining processes.

Before the advancing front of civilization, most Indians retreat into one of three situations: they remain in their own miserable villages, they are gathered into a mission, or they stay in the new Xingú National Park. The Villas Boas brothers, Claudio and Orlando, are trying to soften the impact of civilization and to protect the Indians by sometimes transporting them to the Xingú National Park where inaccessibility insures some measure of protection for the indigenous way of life. It is not evident just how long overland inaccessibility will last, since Brazilians excel at road building, and the pace of their road network expansion is ever quickening.

Notes transcribed from the notebooks of the medical researchers are recorded, sometimes graphically, and fully document the fragility of life among the Indians, who have little resistance to the diseases that accompany the advance of civilization. "Local birth control can be as simple as it is gruesome. After about 28 weeks of pregnancy the woman, lying on a hard surface, grasps the uterus through her abdominal wall and breaks the baby to pieces. Delivery of the stillbirth follows quite rapidly. Maternal death-rate for this procedure is not too high." Although the doctors did all they possibly could to alleviate pain and suffering among the Indians with whom they came in contact, it is only too obvious that their efforts were inadequate for the magnitude of medical needs.

One of the most interesting parts of the narrative account is the last three chapters, which deal with the settlement process and the manner in which squatters build their shacks along the road right-of-way and then proceed to eke a living from the land. These chapters provide a vivid and convincing record of how Brazilians perceive Mato Grosso. To them, it is an area where land could be bought for pennies an acre before a road was put in. They see the area becoming highly valorized by the extension of a road. The land becomes especially valuable once the forest is cut down and colonial grass is planted for cattle grazing. The growth of urban markets for beef is impressive, and the extension of the cattle frontier into the remote interior of the country is a response to that demand for beef. Much of the development has involved single tracts of many hundreds of square miles in area. The development process is often well financed by eastern banks and the management of the fazendas is frequently provided by professional farm managers from São Paulo.

"The Villas Boas brothers believe that the tribes as yet uncontacted will suffer in the age-old fashion when they are finally encircled by the advance of progress. Both sides are suspicious, the pioneering Brazilians and the waiting Indians, and both sides suffer. Even if there is no actual slaughter, the trauma of both disease and contact is a peril only to the Indians. Smallpox or the grippe will attack them as severely as any spattering of bullets from a frightened pioneer."

It is difficult to summarize this book. It is a visual feast because of its incredible color photography. The situation and the process depicted is controversial. What is going to happen to the Indians of Brazil's interior? Even if one knew, what difference would it make since the Brazilians are committed to effective occupation of all their national territory?

Brazil is rapidly becoming an industrial nation—and technology creates problems. With bulldozers and chain saws man can denude forested areas more quickly than ever before. And with wonder drugs, peoples' lives can be preserved so that they can live miserably until an even unhappier old age. Nonetheless, Brazil is a microcosm of historical, geographical, and cultural conditions. The keen observer, arriving in Brazil, experiences an existentialist shock between the truly monumental problems of hunger, disease, and lack of shelter on the one hand, and the burgeoning technical apparatus and urban glitter of a São Paulo or Brasília on the other. The country is indeed an archipelago of more developed cities within a large, underdeveloped hinterland.

The Brazilian philosopher Vincente Ferreira da Silva wrote in some of his short essays that in Western culture and thought, man hates nature, for ever since his expulsion from Eden man has wanted revenge. The whole thrust of Western action has been the domination of rational thought processes over nature. In the eighteenth and nineteenth centuries, man gradually came to understand nature; with the twentieth century he has succeeded in changing it. Is it possible that the Brazilians will follow the Americans and destroy nature in order to replace it with an industrial park? Perhaps we can say that in the deep interior of central Brazil we see an almost laboratory situation of how man is confronting prehistory with the present, and how he is changing the face of the earth in accordance with his momentary cultural definitions of resources. It is a grim yet fascinating story.

Kempton E. Webb is professor of geography at Columbia University and director of its Institute of Latin American Studies.

More Reviews

THE GEM KINGDOM, by Paul E. Desautels. *Ridge Press/Random House, $17.95; 252 pp., illus.*

There are not many popular gem books on the market, even though the lure of gems has persisted, strong and abiding, throughout human history and the shifting whims of fashion. Indeed, in a world increasingly adorned with plastic and mass-produced trivia, the timeless appeal of natural gemstones becomes more compelling than ever.

Although there are some two thousand natural inorganic minerals, only about sixteen have the beauty, durability, and rarity that single them out as possible gemstones. These characteristics, especially in earlier days, were wedded to a mystical significance, so that gems were valued not only for personal adornment, but as talismans with wide-ranging magical properties. Amethyst was thought to cure drunkenness; a giant sapphire under the earth made the sky blue; opal brought bad luck.

The closely related sciences of mineralogy and gemology gave the world a different, but no less interesting, view of gems as the stable and enduring manifestations of a chemically active, churning earth. Gemstones came to be categorized by their intrinsic properties. Firm identification became possible with specialized, often simple techniques, which Desautels presents in a nontechnical way. As he points out, such techniques have led to a reclassification of some of the famous gems of history. Many so-called rubies, for instance, including the Black Prince ruby in the crown of England, are really spinels.

But of course most people rarely have access to the knowledge and instruments for distinguishing genuine natural stones from imitations, synthetics, or dyed stones. So an enlightening chapter takes up the making and faking of gems, substitutions, built-up and treated gems,

and such regrettably misleading common names as Brazilian topaz for quartz. It may leave you determined to avoid Eastern bazaars when buying gems and to stick to reputable jewelers or learn the science yourself.

Ranging from such practical applications to purely esthetic pleasure, *The Gem Kingdom* should have wide appeal. It chronicles the discovery and mining of some of the greatest gem deposits in the world, from South African diamonds to Colombian emeralds. It describes precious stones in their many varieties and numerous, equally lovely semiprecious stones. It reveals the history, methods, and artistry of gem-carving and faceting. There is a chapter about the crown jewels of royalty and another devoted to jade, which has been around as a gem for more than four thousand years and, in its two different mineral forms, was revered by the widely separated cultures of China and the Aztecs.

Illustrations appear every few pages. There are some interesting and quaint old sketches and line drawings, but most of the pictures are Lee Boltin's color photographs of gems, jewels, and carvings, usually filling entire pages or two-page spreads. Although it is regrettable that there is rarely any indication of scale, the photography is superb, and the parade of natural and man-fashioned beauty through these pages is surely unsurpassed in any other gem book.

Altogether, a book to be read, browsed through, and enjoyed through the years.

BARBARA BLAU CHAMBERLAIN
Geologist and Author

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This list details the photographer or other source of illustration by page.

COVER—Carl Roessler
8-10—AMNH
15—Norman Frank
18-19—Melvin Barton
20—AMNH
24—AMNH
31-37—Carl Roessler
39—Jet Propulsion Laboratory
40-41—Helmut Wimmer
43-46—Charles L. Hogue
48-53—Big Bear Solar Observatory
55-63—Jerome R. Mintz; except map—AMNH
64-70—M. Philip Kahl
72-75—Vicky McMillan
76—AMNH after William McMillan
80—Norman Frank
81—Alan Ternes
82-83—The Bettmann Archive, Inc.
84—Norman Frank
88—Courtesy of George Rainbird Ltd.

Suggested Additional Reading

SEEING IS BELIEVING

VISUAL THINKING. R. Arnheim. Univ. of California Press, Berkeley, 1969.

UNDERSTANDING MEDIA. M. McLuhan. Signet Books, New York, 1966.

WORLD AS VIEW AND WORLD AS EVENT. W. J. Ong. *American Anthropologist*, August, 1969.

A RESURGENCE OF RABIES

VIRAL AND RICKETTSIAL INFECTIONS OF MAN. F. L. Horsfall and I. Tamm. J. B. Lippincott Co., Phila., 1965.

EPIDEMIOLOGY OF RABIES. M. M. Kaplan. *Nature*, February 1, 1969.

VETERINARY MEDICINE AND HUMAN HEALTH. H. O. Schwabe. The Williams & Wilkins Co., Baltimore, 1969.

PROPHYLACTIC SERVICES OF THE CLEANING SHRIMP

CRUSTACEANS. W. L. Schmitt. The University of Michigan Press, Ann Arbor, 1965.

ASPECTS OF THE BIOLOGY OF SYMBIOSIS. T. Cheng, ed. University Park Press, Baltimore, 1971.

THE HIDDEN SEA. D. Faulkner and C. L. Smith. The Viking Press, Inc., New York, 1970.

THE GREENING OF DOCTOR HOGUE

THE TROPICAL RAIN FOREST. P. W. Richards. Cambridge University Press, New York, 1952.

FOREST ECOLOGY. S. H. Spurr. Ronald Press Company, New York, 1964.

INSECT LIFE IN THE TROPICS. T. W. Kirkpatrick. Longmans, London, 1957.

THE FIERY SUN

OUR SUN. D. H. Menzel. Harvard University Press, Cambridge, 1959.

SOLAR ECLIPSE. D. H. Menzel and J. M. Pasachoff. *National Geographic*, August, 1970.

TROUBLE IN ANDALUSIA

THE SPANISH LABYRINTH. G. Brenan. Cambridge University Press, New York, 1960.

THE PEOPLE OF THE SIERRA. J. A. Pitt-Rivers. Phoenix Books, Chicago, 1961.

THE SPANISH REPUBLIC AND THE CIVIL WAR: 1931-39. G. Jackson. Princeton Univ. Press, Princeton, 1965.

THE PINK TIDE

THE FLAMINGOS. R. P. Allen. Research Report No. 5, National Audubon Society, 1956.

THE MYSTERY OF THE FLAMINGOS. L. H. Brown. Transatlantic Arts, Inc., Levittown, 1960.

MATING OF THE FATHEAD

THE LIFE STORY OF THE FISH. B. Curtis. Dover Publications, Inc., New York, 1961.

BEHAVIOR. M. E. Brown, ed. Vol. II of THE PHYSIOLOGY OF FISHES. Academic Press, Inc., New York, 1957.

MODES OF REPRODUCTION IN FISHES. C. M. Breder, Jr. The Natural History Press, Garden City, 1966.

Look what George Vail caught in Lake Erie on June 10, 1971

George Vail, Hamburg, New York, has been catching fish in Lake Erie since 1945. And he has been quite successful at it. He regularly catches perch, bass, pike, and other kinds of fish just off-shore from our steel plant near Buffalo.

George doesn't agree with those who wring their hands and claim the lake is "dead" or beyond hope. Others share his view. For example, Dr. W. T. Pecora, Director, U. S. Geological Survey*, wrote in the August 1970 issue of *Mining Congress Journal.*

"We frequently hear that Lake Erie is dead. This is pure rubbish. Lake Erie is the shallowest of the Great Lakes, was created about 20,000 years ago and, barring another Ice Age, has several thousands of years yet to go before senility. The western part of the lake is extremely shallow and receives a large amount of natural organic material transported from the surrounding terrain. Here is where the algae growth has always been present. Lake Erie has continually produced about 50% of the fish catch of the entire Great Lakes system, consistently over the past 100 years. This is not a mark of a dead lake."

Technical Report No. 3 of the Great Lakes Fishery Commission, Ann Arbor, Michigan, presents data documenting Dr. Pecora's remarks.

Lake Erie does, of course, have serious pollution problems and we are not about to understate them. And our steel plant near Buffalo has contributed to this pollution. For several years we have been working on solutions. Late last year we completed a $24 million program to control water pollution at this plant alone.

Of the 320 million gallons of lake water taken into the plant daily, about one-third becomes contaminated. This is processed through the plant's waste water treatment facilities before it is returned to the lake. This treated water not only meets New York state requirements for suspended solids and oil, it substantially exceeds them.

We will continue to clean up our air and water discharges wherever we have operations. We hope others will do their share, too.

**Dr. Pecora is now Under Secretary of the Interior.*

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NATURAL HISTORY

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY INCORPORATING NATURE MAGAZINE

The American Museum of Natural History

Gardner D. Stout, President *Thomas D. Nicholson, Director*

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Authors

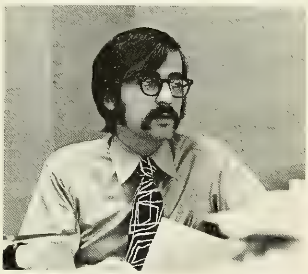
Imaginary interviews with some of history's most influential scientists, such as Galileo, Newton, Herschel, and Darwin, were the subject of a recent BBC television series. The principal figure in all of the programs was **Michael Hoskin**, whose years of research in scientific biography inspired the series. Hoskin, a fellow at Churchill College, Cambridge, where he is in charge of the Archives Centre, is founder and editor of the annual *History of Science* and the *Journal for the History of Astronomy*. His book, *The Mind of the Scientist*, from which "A Chat with Charles Darwin" is excerpted, was published this spring by the Taplinger Publishing Company.

Michael Hoskin

Robin W. Doughty first became interested in conservation in his native England, an interest that led to his dissertation, "Feather Fashions and Bird Preservation," for his doctorate from the University of California at Berkeley. He has done field work in the Farallon Islands of California, where he investigated the historical ecology of commercial egg gathering, and in the Amazon River Basin, where he studied the trade in wildcat skins and ornamental feathers. Doughty, assistant professor of geography at the University of Texas at Austin, is now planning research on the history and ecology of alien and endangered species in Texas.

Robin W. Doughty

It was through his discussions with Doughty regarding ecologically deleterious business trends that **Michael Morrison** became concerned about the advent of the shorter work week. Morrison, who serves as a Washington correspondent for McGraw-Hill Publications, specializes in writing about energy resources. He explains that his association with Doughty is "a natural one: He's an ecologist, I'm a business journalist, and most of the environmental problems in this country are in some way related to commerce." The coauthors of "The Three-Day American Pleasure Trip" are planning a book on the four-day work week and its potential impact on the landscape.



Michael Morrison

Learning to pilot a plane was but one of the sticky problems **Charles Walcott** faced in the course of his bird-navigation experiments. By tracking homing pigeons over much of Massachusetts, he has sought to discover what cues the birds use to return to their lofts. The engine he is tinkering with, above right, belongs to the light plane used in pigeon pursuit, which has, incidentally, become a familiar radar blip to certain air traffic controllers. Walcott is continuing his field work with pigeons as part of the larger question of how birds are able to migrate between distant points. He is associate professor and chairman of the Department of Cellular and Comparative Biology at the State University of New York at Stony Brook.

Charles Walcott

Intrigued by the peculiar light effects he observed during the total solar eclipse of 1954, **Sam Silverman** began a lengthy inquiry into the nature of the changes of sky color that occur when the sun is obscured by the moon. To learn some of the answers, Silverman, who is chief of the Polar Atmospheric Processes Branch, Aernomy Laboratory, at the Air Force Cambridge Research Laboratories in Bedford, Massachusetts, also conducted studies of the 1959, 1963, 1965, and 1966 total solar eclipses. During the 1963 eclipse, his research group obtained the first high-resolution photometric information on sky color changes; from observations of the 1966 eclipse, the group identified and resolved such influencing factors as elevation and zenith angle effects. Silverman has also investigated the polar upper atmosphere and conditions affecting sky brightness.

Sam Silverman

Shortly after joining the Air Force Cambridge Research Laboratories as a physicist in 1970, **Gary Mullen** started searching through the literature of previous eclipses. What he found was a veritable storehouse of human-interest stories describing the attempts of early investigators to view solar eclipses from highly advantageous, but often inhospitable and remote, sites. Such background reporting is no longer found in technical journals, and with so many professional and ama-

Gary Mullen

teur scientists planning to journey to Canada to observe the July 10 eclipse, Mullen and Silverman decided that a look at the humorous side of past expeditions could prove a valuable guide for the peripatetic astronomers.

To trace the maritime history of Mediterranean civilizations, **Frederick H. van Doorninck, Jr.**, dons

Frederick H. van Doorninck, Jr.

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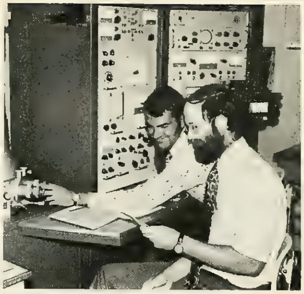
scuba gear and excavates ancient shipwrecks. His underwater archeological work has included service as assistant director of the University of Pennsylvania expeditions, which excavated a seventh-century Byzantine merchantman and a fourth-century Roman trade ship near the Turkish island of Yassi Ada in the Aegean Sea. The artifacts recovered are providing valuable information about the cultures that built and manned the ships. An assistant professor of Greek and classical archeology at the University of California at Davis, van Doorninck wrote the chapter on Byzantine shipping for the upcoming *A History of Seafaring,* from which "The Navy from Constantinople" is excerpted. The book will be published in the United States this fall by Walker and Company.

The return of beavers to many heavily settled eastern states is making scientists curious and leaving more than a few farmers per-

John W. Miller

plexed. To learn about the ecology of recolonization, **John W. Miller** has studied more than fifty beaver colonies in the Massachusetts–Vermont border area since 1968. His work has concentrated on the behavior of these large rodents and the effects of their pond making on the surrounding environment. Miller, who is presently lecturing on writing at Hunter College in New York City, has also conducted research at the Department of Animal Behavior of The American Museum of Natural History.

The research team of Armstrong, Deamer, and Mais, based at the University of California at Davis, began producing scanning electron micrographs of biting insects when



John J. Mais, left, and Peter B. Armstrong

their investigative attention was directed to the valley black gnat, an insect that was making life miserable for people in the Sacramento Valley. The miniscule gnat, too small to have its structure examined in detail by the naked eye, was revealed in all its complexity and beauty by this specialized electron microscope.

Peter B. Armstrong, an assistant professor of zoology, has done extensive work on the mechanism of adhesion between cells in animal tissue and the role of adhesive interactions in controlling the migratory behavior of cells during embryonic development.

David W. Deamer's research has concentrated on the structure and function of biological membranes. An associate professor of zoology, he plans to conduct electron microscope studies of amphibian eggs.

John J. Mais, a staff research associate, provides most of the technical expertise essential to the operation of the scanning electron microscope.

David W. Deamer

Letters

Ma Bell's Zoo

Among the nonhominid bones I would like to pick with your article "A Trip Through Ma Bell's Zoo" (April, 1972) is the description of the Manhattan family name Turtle. You state that the turtle is an amphibian. This is true only in the typological sense in which seals, penguins, and scuba divers are also amphibians. In the phylogenetic sense in which you presumably intended the statement, the turtle is, however aquatic in habit, a reptile by descent. In fact, the chelonian order to which it belongs is paleontologically second in antiquity only to the rhynchocephalians, represented by the lizardlike tuatara of New Zealand.

To compound confusion, the English common noun *turtle*—like the noun *dolphin*—denotes two distinct species, each belonging to a different vertebrate class. In its older sense, going back to the tenth century, a turtle (from Latin *turtur*) is a dove, as it remained in the King James Bible, in which The Song of Solomon characterizes lovers' springtime as heralded by "the voice of the turtle"—surely a birdsong rather than a reptilian phonation! In its later sense, beginning toward the end of the sixteenth century, a turtle (from the French *tortue*) is a tortoise.

And, as if this were not enough, the proper name Turtle may be derived not only from the turtledove but also (with its by-form Thirkell) from Thurkettle, an Old English name meaning "thunder-kettle," or "Thor's cauldron."

ROGER W. WESCOTT
Professor of Linguistics
Drew University

I enjoy your magazine very much, but when a reptile is slighted it makes me cold-blooded.

ARTHUR B. BUSBEY, III
Austin, Texas

The remarks on elephants give an impression of proper respect for that noblest of beasts, but show no real depth of understanding. The bearers of that illustrious name quite properly insist on the more becoming classical spelling. Look under "O," sir. You will find a modest-sized, but by no means negligible, herd of Oliphants.

GEORGE BREWSTER
Arlington, Virginia

In the Portland, Oregon, telephone directory I find five Oliphants.

ROBERT W. LEONARD
West Linn, Oregon

Anthropology for Peace

After two years of trying to devise my own anthropology program for fourth graders, I decided to try "Man: A Course of Study" ("If You Were a Baboon, How Would You Tell Your Mother You Were Hungry?" April, 1972). The response of my pupils was gratifying and exciting! The concepts introduced by this course are far more basic to an understanding of man and his relationship to the environment than the "tons of tin exported by Bolivia" approach of traditional social studies courses. "Bunga of the Jungle" in standard geography books is presented in such a stilted and unrealistic manner that children usually come to resent him. The purpose of social studies is defeated before it has begun.

I have always believed, and am now convinced, that if children can be introduced to anthropology and its approach to the study of man before their own values have prejudiced their attitudes, they will grow up with a true tolerance for, and understanding of, other peoples of the world. Perhaps through education of this sort we can shape a peaceful world.

ELIZABETH C. RIGHTER
West Chester, Pennsylvania

Rapid Recovery

The postscript to the article "The Elephant Man" (March, 1972) gives an account of Edward VII's appendectomy and subsequent recovery and coronation that is too lively for even that notably active monarch.

The operation did not take place on "the day before the prince was crowned king of England in January, 1902." Queen Victoria died in January, 1902, and Edward immediately became king. But he was neither crowned nor operated on then. The *Dictionary of National Biography* gives the following account:

> In the summer of 1902 Treves' fame became suddenly world-wide. On 24 June, two days before the date fixed for his coronation, King Edward VII became acutely ill. His condition was diagnosed as perityphlitis. Treves had been called in by the physicians in attendance. After consultation with Lord Lister and Sir Thomas Smith, he operated. The King made a good recovery and was crowned on 9 August. Treves was created baronet in the same year.

Yours for rapid recoveries and return to duty,

KEITH DOWDEN
West Lafayette, Indiana

An Unexplained Hatred

The three-part article by George B. Schaller, "Predators of the Serengeti," (February, March, and April, 1972) has made me curious about the hatred for wild dogs by even confirmed "conservationists," who are moved to a rampage of extermination when sighting a pack. Occasionally during television interviews, I have heard men express their contempt of the animal and relate how they shot entire packs whenever they came across them. But never have I heard them give a reason for their hatred.

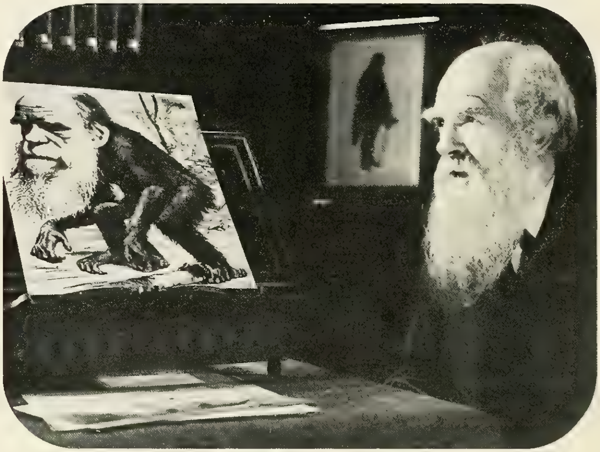
Schaller also does not give a reason, but refers to the baffling occurrence by saying of the wild dog that "it does not seem to be the kind of animal that could arouse man's passion to the extent that it has—being relentlessly and irrationally persecuted throughout its range." After reading his observations of the animals, I see absolutely nothing objectionable about them; in fact, I find their social concern and protection for one another very admirable and superior to other animals.

What is the case against the wild dog, and is its existence going to be in jeopardy?

NANCY WEDDELL
Hinsdale, Illinois

A Chat with Charles Darwin

The author of *The Origin of Species* was recently portrayed on British television. His appearance was the brainchild of an imaginative science historian who re-created an interview with the long-since departed champion of evolution



by Michael Hoskin

In his early manhood Darwin was capable of considerable feats of endurance in South American expeditions, but for many years now he has had to nurse his health. He is probably suffering from an obscure disease contracted in South America, one that leads to a feeling of lassitude and loss of drive. But the disease is not understood, and he is widely suspected of mere hypochondria. As a result he lives in the shelter of his large and devoted family, rarely venturing into the outside world and avoiding social contacts. He is fortunate in having been provided for by his father, so that he has never had to struggle to earn his own daily bread; instead he has enjoyed indefinite leisure in which to pursue his elaborate researches.

As a person he is simple to the point of naïveté. His wife said: "He is the most open transparent man I ever saw, and every word expresses his real thoughts." He has a sense of fun, and is exceedingly thoughtful and generous. He tends to avoid controversy and prefers others to fight his battles for him, but he has high principles and an ability to see many sides to a question.

Hoskin: Mr. Darwin, it's an extraordinary fact that most of the ideas that went into your theory of evolution are to be found in the writings of your own grandfather. How much did his work influence you?
Darwin: I read my grandfather's book *Zoonomia* when I was young, and I admired it greatly. But when I read it a second time after an interval of ten or fifteen years, I was disappointed in it—the proportion of speculation was so large in comparison with the facts he gave. In the same way a fellow undergraduate told me of my grandfather's French contemporary Lamarck, and his views on evolution; but as far as I can judge this had no effect on me.
Hoskin: But the idea of evolution was in the air?
Darwin: Well it had certainly been discussed, but I never came across a serious naturalist who believed that species do change. But I think it is true that a great many well-observed facts were stored in the minds of naturalists, ready to take their proper places as soon as a theory was explained to account for them.
Hoskin: What was it like, having a famous grandfather?
Darwin: Oh, he died before I was born. It was my father who dominated the family. He was the largest man I ever saw, twenty-four stone of him. But his mind was not scientific. He didn't try to express his knowledge under general laws.
Hoskin: And your mother?
Darwin: She died when I was eight, and I can hardly remember anything about her. It was a year after that that I went to Dr. Butler's great school at Shrewsbury, where I stayed until I was sixteen. But the school as a means of education to me was simply a blank—the studies were strictly classical.
Hoskin: Latin and Greek? From what you say it sounds as though you didn't come top of the class.
Darwin: When I left the school all my masters thought me a very ordinary boy, rather below average. And my father once said to me, "You care for nothing but shooting, dogs, and rat-catching—you will be a disgrace to yourself and all your family."
Hoskin: You had no scientific interests at school?

Darwin: I collected minerals and insects—*dead* insects, as my sister told me it was wrong to kill insects just to make a collection. And towards the end of my school life I helped my brother in his chemical experiments—he had a laboratory with proper apparatus in the toolhouse in the garden. This was the best part of my education, though Dr. Butler didn't approve at all, and it showed me, practically, the meaning of experimental science.
Hoskin: What did your father make of all this?
Darwin: Well, I was doing no good at school, so when I was sixteen he sent me to Edinburgh University to study medicine. But I felt sure that he would leave me enough money to live on, and so I didn't make any great effort to learn medicine.
Hoskin: Did you find Edinburgh an improvement on Shrewsbury?
Darwin: No, the instruction was entirely by lectures, and these were intolerably dull. Dr. Duncan's lectures on drugs at eight o'clock on a winter's morning are something fearful to remember. Anyhow, human anatomy disgusted me.
Hoskin: Not a promising start to a medical career!
Darwin: No. And so when my father saw that I didn't like the thought of being a physician, he proposed that I should become a clergyman. This meant I must take a degree at one of the English universities.
Hoskin: Then your years at Edinburgh were a complete waste of time?
Darwin: No, I made friends with several young men fond of the natural sciences. I used to go with one of them to collect animals in the tidal pools, and I dissected them as well as I could. And during my second year I attended Professor Robert Jameson's lectures on geology and zoology; but they were incredibly boring. The sole effect they produced on me was the determination never, as long as I lived, to read a book on geology or in any way to study the subject.
Hoskin: How did you react to your father's proposal that you become a clergyman?
Darwin: I asked for some time to consider. But as I did not then doubt the strict and literal truth of every word in the Bible, I soon persuaded myself that our creed must be fully accepted. So I went to Cambridge, early in 1828.
Hoskin: I hope you had better luck with the teaching there!
Darwin: No, I'm afraid my three years in Cambridge were wasted as completely as my time at Edinburgh and at school—as far as the academical studies were concerned.
Hoskin: You studied what, classics . . . ?
Darwin: . . . and mathematics, and William Paley's books, which we all *had* to study. The logic of Paley's reasoning appealed to me.
Hoskin: Paley gives the old argument for the existence of God, doesn't he? From the evidence of design in nature.
Darwin: Yes, Paley says that if we find a watch on the ground and pick it up and examine it, we soon convince ourselves that the watch had a maker who designed it for telling the time—even though we never actually saw him at work. In the same way, he argues, if we examine an eye we find it is wonderfully designed for seeing, and so must have a designer, who is God.

This argument—which then completely convinced me—was the basis for the then accepted belief that all species had remained fixed and immutable since their creation.
Hoskin: Did you go to any of the courses, in view of your experiences in Edinburgh?
Darwin: Not many, but I did attend John Henslow's lectures on botany. Henslow used to take his pupils on field excursions, and lectured on the rarer plants or animals which were seen. These excursions were delightful.
Hoskin: And very forward looking for their day.
Darwin: Yes. But nothing I did at Cambridge gave me so much pleasure as collecting beetles. It was the mere passion for collecting. I remember one day I tore off some old bark from a tree and saw two rare beetles there. I seized one in each hand—but then I saw a third and new kind, which I couldn't bear to lose. So I popped the one that I held in my right hand into my mouth! Alas, it ejected some intensely acrid fluid, which burned my tongue, so that I was forced to spit the beetle out—and I lost it and the third one as well.
Hoskin: But at least you held on to one of them!
Darwin: Yes! But at Cambridge what influenced my career more than anything else was my friendship with Professor Henslow. I took long walks with him most days, and some of the dons called me "the man who walks with Henslow." It was he who persuaded me to study geology in my last two terms in Cambridge, and it was he who asked Professor Sedgwick to let me accompany him on his geological investigations in North Wales.

Sedgwick's very first conversation with me made a big impression on my mind. I told him of a tropical shell that a laborer claimed he had found in an old gravel pit near Shrewsbury. But Sedgwick said at once that it must have been thrown away by someone into the pit—and he added that if it had really been embedded there it would be the greatest misfortune to geology.

Samuel Wilberforce, bishop of Oxford.

Black-Browed Albatross nesting

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Hoskin: Because it would disprove the current theories.
Darwin: Yes. But I was utterly astonished at Sedgwick not being delighted at so wonderful a fact as a tropical shell being found near the surface in the middle of England. Nothing before had ever made me realize that science consists in grouping facts so that general laws or conclusions may be drawn from them.
Hoskin: And one could go on to say that a fact only becomes a *scientific* fact when it is relevant to some theory—when it tells for or against some hypothesis. And one exception may be devastating.
Darwin: Yes. How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any use.

Well, on returning home from Wales I found a letter from Henslow telling me that Captain Fitzroy of H.M.S. *Beagle* was willing to give up part of his own cabin to any young man who would volunteer to go with him as naturalist on a voyage round the world. Fitzroy wanted someone to gather evidence to help defend the strict and literal truth of every statement in the Bible.
Hoskin: But were you free to go? Weren't you studying for the Church?
Darwin: Yes, and my father thought that to go on this wild scheme would be disreputable to my character as a clergyman. You know, the voyage of the *Beagle* was by far the most important event in my life and determined my whole career. Yet it depended on my uncle offering to drive me thirty miles to Shrewsbury to talk with my father.
Hoskin: And your father gave his consent.
Darwin: In the kindest manner.
Hoskin: How long did the voyage last?
Darwin: Five years, most of which were spent along the shores of South America. I have always felt that I owe to the voyage the first real training or education of my mind. My powers of observation were improved—but far more important was the investigation of the geology of all the places we visited, because in geology you have to reason.
Hoskin: How do you mean?
Darwin: Well, when you first examine a new district the chaos of rocks seems hopeless. But if you record the layers and the nature of the rocks and fossils at many points, reasoning it out and predicting what you will find elsewhere, you discover that the general structure then becomes more or less intelligible.
Hoskin: You mean that you began to form hypotheses on the evidence that you first came across, and then you tested these hypotheses against the later evidence?
Darwin: Yes. And I studied the first volume of Lyell's *Principles of Geology*, which Henslow had given me, though he warned me on no account to accept Lyell's views.
Hoskin: He wanted you to use the book merely as a compendium of facts.
Darwin: Yes.
Hoskin: I suppose he didn't like Lyell's views because Lyell insisted that the Earth as we know it has been formed over millions of years, and simply by the forces we see at work today. No divine interventions, no great upheavals, only *continuous* processes—ones that science can investigate.
Darwin: Exactly. For example, Lyell claimed that long lines of inland cliffs have been formed and great valleys excavated by the agencies which we *still* see at work. But many geologists found this a great difficulty, because the mind cannot grasp the full meaning of even a million years.

In the same way the main cause of our unwillingness to admit that one species has given birth to other and distinct species is that we are always slow in admitting great changes of which we do not see the steps. The mind cannot add up the full effects of many slight variations accumulated during an almost infinite number of generations.

Now on the *Beagle* I studied Lyell's book *carefully*. And the very first district I examined showed me clearly the wonderful superiority of his method of treating geology.
Hoskin: And soon you were convinced that Lyell was right that the time-scale of the Earth is to be measured in millions of years.
Darwin: Yes.
Hoskin: But what led you to believe that species had changed? After all, Lyell himself was opposed to this, wasn't he?
Darwin: Yes, and he maintained this position for thirty years, but gave it up on reading my work—something which I think is without parallel in the records of science.
Hoskin: Yes, most scientists would rather die than alter their minds on a fundamental question! But what led you to believe that species change?
Darwin: Well, during the voyage of the *Beagle* I was deeply impressed by a number of things: by discovering in one place great fossil animals covered with armor like that on the existing armadillos; by the way in which closely allied animals replace one another as you proceed southwards over the continent of South America; and by the South American character of most of the animals of the Galápagos Islands; and more particularly by the way in which they differ slightly on each island of the group.
Hoskin: Could we take these in turn. First you found great animal fossils that looked like existing animals *except* that they were far bigger in size. And you wondered why they had died and others so similar were still living.

Then, in addition to these examples of similar animals separated in time, you found many examples of similar animals separated in *space*—as you traveled south the species changed *gradually* from place to place. And you wondered why this should be so. And the most striking example of this you found in some islands hundreds of miles out in the Pacific Ocean. There the animals were *nearly* the same on each island, but not *quite*.
Darwin: Yes. Unfortunately until my investigation was nearly complete it never occurred to me that on islands only a few miles apart and with the same physical conditions the animals would be dissimilar. Yet in the thirteen species of groundfinches you can trace a nearly perfect series of steps from a beak that is extraordinarily thick to one that's so fine you could compare it to a warbler. And if you show the Spaniards a tortoise from one of the islands they can tell you at once which island it has come from, simply from the

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form of its body, the shape of its scale, and its general size. It was clear that facts like these could only be explained on the supposition that species gradually become modified.

The subject haunted me. And so a few months after my return to England, I opened my first notebook for facts relating to the origin of species, and I never ceased working on this for the next twenty years.

Hoskin: But what about the question of what *causes* species to change?

Darwin: And the question of why organisms of every kind are so beautifully adapted to their habits of life—a woodpecker to climb trees, or a seed to be scattered by hooks or plumes. Until these could be explained it seemed to me almost useless to try to prove by indirect evidence that species have been modified. And they couldn't be explained by the will of the organisms, or the action of the surrounding conditions, as some writers have tried to do—such as my grandfather and his French contemporary Lamarck.

Hoskin: Because, for example, conditions on each of those islands you visited were exactly the same, while at the same time the species of finches and tortoises were *different.* So somehow the barrier of a mile or two of water must have been enough to allow each species to develop its own characteristics.

Darwin: Yes.

Hoskin: So what did you do?

Darwin: Well, about fifteen months after I had opened my first notebook, I happened to read for amusement Thomas Malthus's *Essay on Population* and . . .

Hoskin: Excuse me. Malthus maintained, didn't he, that at each generation a population—human, animal, or plant—tends to multiply. For example if, on the average, two human parents have four children, then the population will double with each generation, *provided* the children survive. And after eight more generations you would have more than a thousand to take the place of the first parents.

Darwin: Yes, and he pointed out that in fact the food supplies increase much more slowly.

Hoskin: So that there is a constant check on the population.

Darwin: Yes. Now from my long-continued observations of the habits of animals and plants I was well able to appreciate the struggle for existence which everywhere goes on. And it struck me at once that under these circumstances *favorable* variations, however small, would tend to be preserved, and unfavorable ones destroyed. The result of this would be the formation of new species.

I called this process "natural selection" and the result is the survival of the fittest.

Hoskin: Could we see if I've got this clear? Let's suppose we have a lot of giraffes. Then some will of course be taller than others. But there is not enough food for them all, so the shorter giraffes go hungry and die, while the taller ones can reach higher in the trees for food and so manage to survive and have young ones.

But these young will tend to be tall like their parents—taller, that is, than the average giraffe *used* to be. In this way the average height will increase—and so the later giraffes will be different from their ancestors—in time perhaps so different that we would call it a *new species.*

Darwin: That would be one simple example, yes.

Hoskin: So now you had an idea of what *causes* species to change.

Darwin: Yes.

Hoskin: And this was a grand idea of yours, affecting every living species.

Darwin: Yes. So I was anxious to avoid prejudice. And it wasn't until 1842 that I first allowed myself the satisfacton of writing a very brief abstract of my theory in pencil. Two years later I enlarged it to 230 pages.

Hoskin: You were married by this time?

Darwin: Yes, I was married in 1839. My dear wife has been my greatest blessing; without her my life would have been miserable—because of my ill health.

Hoskin: Did you suffer from ill health during the *Beagle* voyage?

Darwin: No—then I could ride a horse for ten hours at a time, and I thought nothing of sleeping rough for weeks on end. But since my return I have lost much of my time through illness. This is why my wife and I have lived such a retired life. You see, I found that after meeting friends my health always suffered from the excitement, which brought on violent shivering and vomiting attacks. I get exhausted now by seeing and talking with anyone for even an hour—except my wife and children.

Hoskin: Yes, I must be careful not to tire you.

Darwin: Well, I have nothing to report during the rest of my life, except the publication of my various books.

Hoskin: You had time to write many books because you never had to go out and earn your living?

Darwin: Fortunately no—my father always provided for me. And so my chief enjoyment, and my sole employment throughout life, has been scientific work.

Hoskin: The world has left you to get on with it in peace.

Darwin: Yes, and the excitement of it makes me forget my daily discomfort.

Hoskin: We got as far as the longer sketch of your theory.

Darwin: Yes, that was in 1844. Twelve years later Lyell advised me to write out my views pretty fully, and I began to do so on a much larger scale than was afterwards published in my *Origin of Species.*

But my plans were all upset in 1858 when Mr. Alfred Russel Wallace, who was then in the Malay Archipelago, sent me an essay that contained exactly the same theory as mine.

Hoskin: What a dreadful thing to happen to you, and after twenty years' work on the theory! What did you do?

Darwin: With many misgivings, and on the advice of friends, I had Mr. Wallace's essay published jointly with some pieces of mine. But they didn't excite much attention—which shows how necessary it is that any new view should be explained at length.

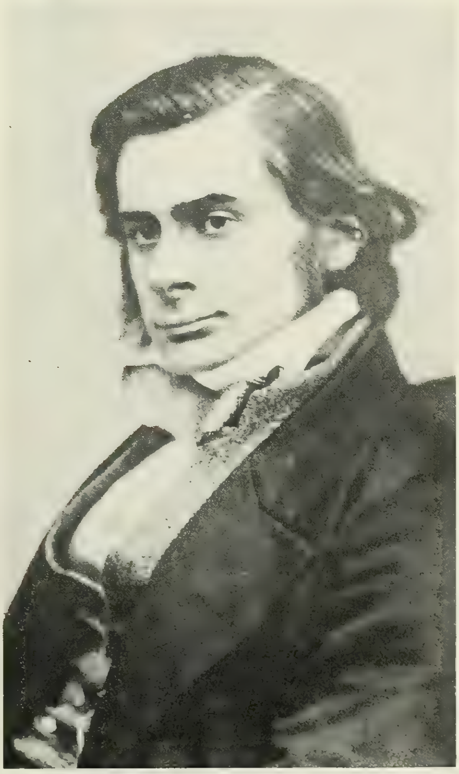
Hoskin: But I expect the shock of Wallace's essay galvanized you into action.

Darwin: Yes! After thirteen months and ten days of hard labor, my *Origin of Species* was published in November, 1859.

Hoskin: Mr. Darwin, one of the most important implications of your theory is that man has animals for his ancestors.

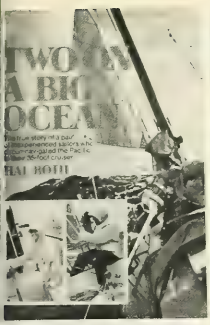
Darwin: That is true.
Hoskin: Did you make this plain in your book?
Darwin: At the time when I first became convinced that species change I could not avoid believing that man must come under the same law. And so I collected notes on the subject—for my own satisfaction, not for a long time with any intention of publishing. But in order that no honorable man should accuse me of concealing my views, I added in my book on *The Origin of Species* that "light will be thrown on the origin of man and his history."
Hoskin: What? You mean to say, only *one* sentence in the whole book?
Darwin: Yes—but of course when I found that many naturalists fully accepted my doctrine of the evolution of species, I worked up my notes into a special treatise on the origin of man. It was published in 1871 as *The Descent of Man.*
Hoskin: And that was no less than twelve years after *The Origin of Species.* And meanwhile friends like Thomas Henry Huxley were fighting your battles for you.
Darwin: That is true. I used to call Huxley "my general agent," and others called him my "bulldog."

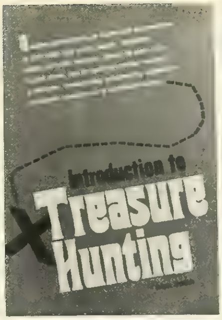
After the *Origin* was published awful fights raged in the newspapers and drawing rooms. There was one pitched battle at a meeting in Oxford—I'm glad I wasn't there; I should have been overwhelmed, with my health in the state it was. But Huxley answered the Bishop of Oxford capitally—whereas I would as soon have died as tried to answer the bishop in such an assembly.

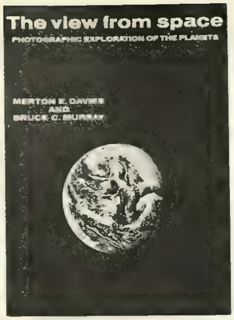

Thomas Henry Huxley

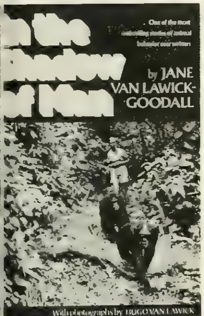
Hoskin: What did the bishop say?
Darwin: It seems he assured his listeners that there was nothing in the idea of evolution; and he asked Huxley whether he claimed descent from a monkey through his grandfather or his grandmother.
Hoskin: What did Huxley say to that?
Darwin: He said he would prefer to have a miserable ape for a grandfather, rather than a man who employed his great talents to introduce ridicule into a grave scientific discussion.
Hoskin: But was the bishop a scientist?
Darwin: No, but he was a spokesman for scientists.
Hoskin: There was no question of a fight with the scientists on one side and the bishop on the other?
Darwin: By no means. But it is true that the old argument for the existence of a personal God—the argument from design in nature, which used to seem so conclusive to me (you know, Paley's argument), fails now that the law of natural selection has been discovered.
Hoskin: You mean that giraffes have long necks, not because God decided to make them that way, but because long necks have helped their ancestors to survive periods of famine.
Darwin: Yes. There seems to be no more *design* in the variability of living things and in the action of natural selection than in the ways the wind blows.
Hoskin: But you are not saying that because one argument for the existence of God proves unsatisfactory, therefore God does not exist?
Darwin: No. But I cannot pretend to throw the least light on such abstruse problems. It is not in our power to solve the mystery of the beginning of all things; and I for one must be content to admit I do not know. I am agnostic.
Hoskin: Mr. Darwin, this caution seems to me to be characteristic of your scientific work also. You took twenty years to publish your theory of evolution, and twelve more to make clear its implications for man. And yet your caution hasn't prevented you from bringing about a revolution in thought. How is this?
Darwin: It is hard to understand. My power to follow a purely abstract train of thought is very limited. And my memory is hazy—and I've no great quickness of wit, which is so remarkable in some clever men, like Huxley. But I don't think it's true to say, like some of my critics, "Oh, he's a good observer but he's no power of reasoning." After all, *The Origin of Species* is one long argument from beginning to end. And I notice things that easily escape attention, and observe them carefully. And I've always had the strongest desire to understand or explain whatever I observed—to group all facts under some general laws—though I've tried always to give up any hypothesis as soon as the facts are clearly against it.

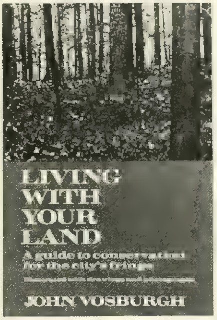
But it's truly surprising that with such moderate abilities I should have influenced the beliefs of scientific men on some important points.
Hoskin: Mr. Darwin, I hope we have not tired you too much. ■

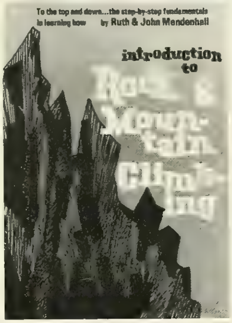












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Perhaps only in poetry can we come close to evoking the ideal place of leisure, the "stately pleasure dome" of our desires. Yet this enduring fantasy—sensual and vague—pervades our actions, particularly when we have time off from the routine of work. Attitudes toward leisure, undefined and nebulous as they are, nevertheless have a direct and measurable impact on the landscape, and for both social and technological reasons, that impact is expanding dramatically. "Let them eat cake" has been translated to "Let them go out and play."

Many Americans are now getting an additional day in which to pursue their fantasies of leisure as a result of a four-day work week. More than 700 American companies now give employees three out of every seven days to themselves, and at least 1,000 companies are contemplating such a shift. The nation's largest employer, the federal government, will run a four-day work week experiment for Social Security workers at the agency's Baltimore headquarters as soon as Congress passes enabling legislation. Municipal employees in Long Beach, California, and Atlanta, Georgia, have switched. Other cities are similarly questioning their allegiance to the five-day week.

Unfortunately, our comprehension of personal free-time management is little advanced beyond that of an adolescent street-corner lounger. Except for a privileged few, humanity has worked most of its waking hours until the early part of this century. Much of the world still does. The two-day weekend, dream of our fathers', has been with us for fewer than fifty years and was exported from North America only in the last twenty years.

The effects of a burgeoning multitude in search of undefined pleasures are readily apparent. Mounds of trash are being spread across the landscape; lines of cars are clogging roads every fair weekend; and deterioration of the nation's parks is accelerating. Uncontrolled construction of everything from golf course condominiums to AIA-designed beach houses and elaborate resort villages is creating a staggering number of personal mini-gardens of leisurely pleasure—often at the terrible expense of what little unspoiled land remains.

The crushing weight of the coming problems caused by expanded leisure can be understood by examining our recent behavior with time off. Visits to national parks, for example, rose from 72.2 million in 1960 to 160 million in 1970. State parks across the country have experienced similar pressures: from 1962 to 1967, attendance increased 36.5 percent and overnight visitation 50.7 percent, while tent and trailer camping jumped 70 percent during the same period. By 1970, the attendance figures for state parks had gone up another 23.8 percent, for overnight visitation 40 percent, and for tent and trailer camping 44.6 percent over what they were in 1967.

These figures are likely to pale before what's coming as the work week contracts. Management consultant Riva Poor, editor of the best-selling book *Four Days, Forty Hours*, surveyed the habits of the new leisure class possessing 72-hour weekends. She and statistician James L. Steele found the most striking increases in travel and related activities: among the four-day workers studied, swimming and boating had increased 319 percent, while hunting and fishing had gone up 95 percent.

To today's water-recreation-minded worker seeking salvation at the lake, the four-day work week will mean the three-day weekend; but to the lake, it will mean the

four-day weekend. Businesses that adjust to the system by opening for trade only four days a week are likely to split fairly evenly in electing Friday or Monday as the additional holiday. The first human wave will hit the lake Friday for a stay through Sunday. The second will be on hand Saturday through Monday. A recreational resource that formerly had five days in which to rejuvenate will now have only three—Tuesday, Wednesday, and Thursday.

Lest that leave life too easy for the lake's ecosystem, some businesses have another four-day work week strategy in which employees are always off Sunday, plus two other days by rotation: Monday and Tuesday the first week, Tuesday and Wednesday the next, and so on. Workers have free time during midweek, and the rotation results in a five-day mini-vacation, from Friday through Tuesday, every sixth week. The inevitable result of so much time off and increased mobility will be a severe case of people pollution. Omnipresent man, not population growth, becomes the quintessential problem.

People pollution got its start in earnest when midcentury affluence began underwriting a bit of travel for nearly everyone. Better highways were constructed, making outlying natural areas accessible to auto-rich urbanites and suburbanites. Next came campers, self-propelled or pulled, equipped with bed, beer-stocked refrigerator, flush

Continued on page 85

by Arthur W. Galston

The Naked Cell

When the final layer of an onion is peeled back, you find strange and wondrous things

Every cell of every plant lives within a "wooden box," or wall, composed mainly of cellulose, plus a few other less well-defined compounds. Most plant physiologists now believe that the cell wall is a secretion of the living part of the cell, and not a truly integral part of the living system. The individual cells are cemented together by pectins, the materials used commercially in making jellies. Sometimes the integrity of plant tissue is upset through invasion by wall-digesting molds. As these molds make their way through plant tissue, they secrete two types of enzymes: pectinases, which separate cells from each other, and cellulases, which enable the mold to digest the cell walls and to get at the living contents of the cell. If we extract these enzymes from the mold, we can use the pectinases to separate cellular masses into individual cells, and the cellulases to digest the wall away from the living protoplast inside the cell. We have, then, a technique for isolating and unwrapping the protoplast, or most elemental unit of plant life.

The protoplast of a plant cell is an active osmotic system; that is, it will quickly take up water from the surrounding medium and expand. Normally, the protoplast, like the bladder of a basketball, is restrained by the rigid outer coat, the cellulose cell wall. But once that wall has been digested by the cellulase, there is no limit to expansion. The protoplast will absorb more and more water and swell until finally, like an overblown balloon, it bursts. To protect the protoplast against such an untimely end, you simply add osmotically active material, such as mannitol (a sugar alcohol), to the medium around the cell. The protoplast becomes equilibrated and does not swell further.

What can we now do with such naked protoplasts, suitably osmotically stabilized and immersed in an appropriate culture medium? In a significant number of cases, protoplasts will re-form cell walls, and will then go on to divide to produce callus masses, or undifferentiated tissue. These behave in a flask like the ordinary callus masses I mentioned in an earlier column ("The Immortal Carrot," April, 1972). That is, they will form roots in response to high auxin levels and buds in response to high levels of cytokinin. This shows that a single isolated protoplast bears within it all the information required for the regeneration of the entire plant; the cell wall carries none of the essential information. The cells formed from the protoplasts presumably are immortal, like those taken from carrots by Gautheret and Nobécourt thirty-five years ago. And, of importance to plant breeders, the naked plant protoplasts are far more amenable to external manipulation than are cells in their cellulose boxes.

The plant protoplasts resemble animal cells in their changeability of form. Animal tissue can also be cultivated—potentially indefinitely—in an artificial medium, although the medium is much more complicated than the one required for plant cells. The animal cell medium must contain some as yet uncharacterized organic materials obtained from immature embryos or from blood serum. In a typical experiment with animal tissue, fibroblast cells are put into a Petri dish containing a culture medium. The cells behave like amoebas, dividing vigorously and migrating over the interface between the glass and the nutrient medium. Unlike experimenters with plant cells, scientists working with animal cells have not yet been able to get the cells to differentiate into organs or the intact organism.

If fibroblasts from two different animals are put into the same Petri dish, they may come into contact and sometimes fuse. To aid this fusion, scientists usually incorporate an inactivated virus into the medium. Although viruses are relatively large particles, they can nonetheless make their way through the usually resistant cell membrane. Proteins on the surface of a virus have an affinity with certain points on the cell membrane. The penetration of the virus through the membrane must involve a local breakdown of membrane structure. Thus, the facilitation of protoplast fusion by inactivated viruses may be due to a local breakdown of the membranes and the spontaneous reformation of membranes across contact surfaces between cells. This could cause cellular fusion. Since the virus is inactive, there are no complications due to virus replication in the cell.

Using this technique of virus-facilitated fusion of animal cells in culture, experimenters have produced in a Petri dish man–mouse hybrids, chicken–hamster hybrids, and a whole host of other combinations that would be impossible to obtain by conventional techniques. Thus, by such parasexual genetic techniques, you can examine the consequences of introducing foreign sets of genes into host cells.

Unfortunately, in the animal experiments just described, nuclear fusion is usually incomplete. In most cases, one of the genomes is progressively eliminated. Thus in man–mouse hybrids the human component becomes diluted until it almost completely disappears. In other instances, parts of the gene set of, say, a chicken cell are incorporated into a mammalian cell and continue to produce proteins that are characteristic of the chicken and not of the mammal. Because of our inability to induce animal cells to differentiate in culture, these experiments cannot yet be carried further to see the morphological consequences of such fusions.

But let us return to the plant. If a single protoplast can regenerate the entire plant, what might happen if two related protoplasts were fused by this parasexual method? Could one take the fusion product, cause it to develop a cell wall, divide into a callus mass, and then regenerate the entire plant? Would it be a normal plant? Would the genes of the two cells be represented in the finished product? Could viable plants be produced in this way? These questions are now attracting the excited attention of many experimental botanists.

Experimenters have already demonstrated that some plant proto-

Continued on page 88

How Green the Revolution

In Asia, the seeds of hope may become the seeds of destruction

The Philippine rice harvest is down 3 percent from last year, and for the second year in a row the country will import massive amounts of foreign rice to satisfy domestic demand. What is so remarkable about this is that the Philippines are the original home and early hope of the highly heralded Green Revolution in rice. The International Rice Research Institute at Los Banos, in the Philippines, developed the "miracle" high-yield varieties of dwarf rice as a means of combating hunger in the Asian tropics. The new varieties were first field tested in the Philippines, and today these varieties occupy proportionately more acreage there than anywhere else.

The Philippine population is increasing at the rate of 3 percent a year, so a 3 percent drop in the production of the country's staple food is a serious matter. But there is much more at stake. The public image of the Green Revolution has been shaped by prematurely optimistic accounts of the Philippines experience. For example, a United States Agency for International Development report written in 1969 begins with these words: "The story of the rapid adoption by the Filipino farmers of the new high-yielding rice varieties is epical in the history of agricultural development." And in 1968 Ferdinand Marcos, the president of the Philippines, campaigned on the promise that his country would never again have to import rice. Assuredly the Green Revolution will be "epical," but whether it will be an epical success or an epical failure remains to be seen.

Articles in the news media have emphasized the technological breakthrough, the "miracle seeds" that will quadruple grain production. But within the scope of the Green Revolution, the new seeds are only one part—in many ways only a minor part—of an immense program of forced social change.

The managers of the Green Revolution hope to achieve nothing less than a non-Communist Great Leap Forward, but there is a real risk that instead they will trigger natural and cultural disasters of a size unprecedented in human history.

Contrary to what most people have been led to believe, the high-yield varieties of rice are not more productive under the usual conditions of peasant agriculture in Asia. In fact, if the new seeds are merely substituted for local varieties, an immediate and drastic decline in output per acre ensues. The so-called miracle seeds are only more productive if they are planted in conjunction with optimum levels of irrigation water, chemical fertilizers, and pesticides. A true miracle seed, designed to meet the existing conditions of peasant agriculture, would have different specifications, since 70 to 90 percent of Asian farm families have no irrigation water and no cash or credit for the purchase of chemical products.

In many other ways the high-yield varieties fall far short of being miraculous. The two main rice varieties, known as IR-8 and IR-5, are only moderately resistant to such common rice plant diseases as bacterial leaf blight, blast, and tungro virus. Because of this lack of resistance to epidemic pathogens and

by Marvin Harris

the insects that carry them, heavy dosages of insecticides and fungicides are an essential feature of the Green Revolution. The current setback in the Philippines is partly due to severe outbreaks of tungro, yellow dwarf, grassy stunt, bacterial leaf blight, bacterial leaf streak, and stem rot. At the International Rice Research Institute, which is sponsored by the Ford and Rockefeller foundations, geneticists are working feverishly on new high-yield varieties that will have greater resistance to these diseases.

Continuous mass application of broad-spectrum insecticides is ecological Russian roulette. Chemical residues, resistant mutations, and the lifting of ecological restraints on secondary vectors will give rise to unpredictable problems. Plant entomologists are holding their breath as they watch whole continents being planted with one or two strains of rice or wheat, creating ecological conditions that never existed before. The potential for continental disasters is awesome.

Another defect of the new rice is that most rice eaters don't like its taste. Presumably once the tastier, native grains are driven from the market, people may get used to IR-5, IR-8, and the other new strains. But in the meantime, high-yield rice sells for 20 percent under the price of the traditional varieties in the Philippines.

Consumer resistance complicates the governmental price support program, another essential "input" of the Green Revolution. The farmer planting the new varieties has many new expenses. If prices fall too far he cannot sustain the costs of irriga-

tion, fertilizers, and insecticides. Massive government-backed loan programs, created to induce farmers to plant the new seeds, are an added hazard. When bank credit is suddenly diverted into the rural sectors of underdeveloped countries, local moneylenders and political bosses inevitably gain more control, heightening the exploitation of farmers and the already excruciating level of corruption. In the Philippines, the disappearance of the revolving funds that were allocated for agricultural credit has already created scandals all the way from Manila down to the smallest hamlets.

Extensive rural unrest is also cited officially as one of the reasons for the drop in rice production, but unrest is a predictable result of the Green Revolution.

Another consequence of the miracle seeds results from their rapid growth. IR-8 and IR-5 mature in 130 days or less, while traditional varieties mature in about 170 days. Although this feature is attractive to the farmers who have adequate supplies of water, since they can plant two crops a year rather than one, such rapid growth means that the rice must be harvested during the rainy season. In contrast, traditional rice varieties are harvested after the rainy season, and the grains can be dried in the sun before being put in bags. For the new varieties, which mature during the wet season, special mechanical driers must be used to prevent mildew and the sprouting of the wet grains. In the Philippines, farmers who lack their own mechanical driers have been receiving 20 percent less than the wholesale price for their rice during the rainy season.

The new varieties of rice are dwarf plants. They are bred to have strong, short, thick stems to support the heavy heads of grain. This feature also was initially alleged to offer protection against typhoon winds. Yet typhoon damage is frequently cited in the official explanation of recent Philippine crop losses. One of the problems may be that the short-stemmed varieties survive the winds but drown if, as often happens, the typhoon is accompanied by extensive flooding.

In India, where rice stubble is the most important food source for cattle, more ominous consequences were narrowly avoided. According to anthropologist Edward Montgomery, the attempt to introduce IR-8 had to be abandoned, at least in part, because the cattle refused to eat the short, thick stalks.

Can we continue to believe that the creation of high-yielding rice was inspired by a vision of miracles for the benefit of the peasants of Asia? I think not. For the peasants, these seeds, with their carefully engineered genetic characteristics, are antimiracles, veritable seeds of destruction. The precise objective of the managers of the Green Revolution is to wipe out the class of small farmers and to replace them with efficient agribusinessmen who will be heavily dependent upon industrial products and world markets.

The program's managers know, and openly propose as development targets, the actual steps for the conversion of peasants into agribusinessmen. One of the first steps for the spread of the new seeds in a country is a commitment from foreign corporations to build chemical fertilizer factories. Corporations will give such commitments once the government of a country shows that it intends not only to subsidize the farmers' purchase of fertilizers and other chemical and mechanical inputs, but also to maintain the price of rice at levels higher than those of the world market. In the Philippines, for example, Esso Standard Fertilizer and Agricultural Company has played a critical role in all phases of the introduction and marketing of the high-yield varieties. According to an Agency for International Development report, Esso installed 400 agroservice stores throughout the Philippines in anticipation of the Green Revolution. To staff these stores, Esso created "a sales staff of agent-representative-entrepreneurs who served as extension agents to promote the rice program and train farmers." These salesmen were recruited from among the "top graduates of the Agricultural College of the University of the Philippines at attractive salaries," and they "became prime movers and innovators in the provinces, working with AID officials and government agents." Esso did not have to extend credit for the purchase of the chemicals; the Philippine government did that.

It was inherent in the design of the new varieties of rice that where private enterprise prevails, the rich farmers will be made richer and the poor farmers poorer. Only those farmers who already have irrigation can use the new seeds effectively; only they can get the credit to buy the fertilizers, pesticides, and herbicides that Esso and other chemical companies are selling (at prices above the world market price). The larger the farm, the easier it is for the owner to obtain credit.

Small owners who resist the Esso salesmen face an ultimate ecological crunch: when the high-yield varieties are harvested, the traditional varieties are still ripening in adjacent fields. These become targets for armies of rodents and insects that are dispossessed by the harvest of the high-yield varieties.

As competition forces the smaller producers into credit-based agribusiness, their hold on their lands weakens. The smaller the farmer, the greater the risk he takes in accepting the lure of the miracle seeds. Not only does he stand to lose his savings, but he may also find himself without any rice to eat. If the new varieties fail for a single year, the small farmer may have to sell his land unless additional credit is extended. There is no indication that the Philippine government is prepared to support the small producers through even a single poor harvest. The inexorable, planned effect of the Green Revolution is for the millions of "inefficient" farmers with small landholdings to sell out. Where they and their families will go is not clear, but my guess is that in the Philippines most of them will end up as low-paid migrant farmworkers or as slum dwellers in the teeming squatments of Manila.

The higher productivity of the miracle seeds will not bring even a temporary respite from the problems of hunger and malnutrition in Asia. Hunger and malnutrition are the result of social inequities and population growth. The Green Revolution is intensifying the social inequities. And by dislocating millions of families and increasing the economic uncertainties of their lives, the Green Revolution plants the seeds of unrestrained population growth and chaos.

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Bird Navigation

Travels around New England in pursuit of pigeons

by Charles Walcott

Eels, salmon, whales, turtles, and birds—and even insects—migrate long distances, sometimes for thousands of miles. While this phenomenon has been studied throughout recorded history, we have as yet no clear answer to the question, How do animals navigate?

The most familiar of these migrating animals are those that perform the most spectacular migrations: the birds. The arctic tern, for example, sometimes flies 11,000 miles each way from the Arctic to the Antarctic, and back, each year. Closer to home, we are all familiar with the northward migrations of robins and bluebirds in the spring. These birds, having spent the winter in the warmer climate of the south, migrate north with the coming of spring. Interestingly, banding birds has shown that many return to the exact place where they were banded; the robin on your lawn this year was probably there last year and will most likely return next. This suggests that migration is far from a haphazard movement north or south. What we would like to understand is how the robin finds its way south in the fall, then returns the following spring to exactly the same place that its journey began.

Douglas G. Smith, now a professor at Stony Brook, releases a pigeon from a moving car. Once the bird has learned to find its way back to the loft, it will be equipped with a radio beacon so that it can be followed.

That most of these birds migrate at night does nothing to make the problem easier, but it does suggest that the birds might be using the stars. And so it seems to be. E.G.F. Kramer and E.M. Sauer in Germany and Steven Emlen at Cornell University have confirmed that some species of birds can make use of the stars to choose a direction of flight.

This conclusion is based on an elegantly simple experiment. During the seasons when they migrate, caged small birds become restless at night, instead of quietly sleeping. During this period of migratory restlessness, they will continually hop from one perch to another. Kramer and Sauer put such birds in a circular cage with a transparent bottom; then, placing it out of doors with a clear view of the sky, they lay underneath the cage and kept track of the direction in which the birds hopped. They found that in the spring such caged birds tended to spend more time on the north side of the cage and in the fall, more time on the south side. On overcast nights, when the stars were not visible, the warblers appeared to be completely disoriented and hopped in all directions equally. By moving the cage indoors to a planetarium, Kramer and Sauer were able to show that the birds would still orient to the north in the spring, but if the star pattern was reversed and the northern constellations appeared in the south, the birds would also reverse their orientation, following the stars.

Several other people tried to repeat these experiments, some of them using complex cages with perches equipped with switches and elaborate electronic counters and computers, but no one was very successful until Steven Emlen tried it with a superbly simple cage. He built a circular arena about 14 inches in diameter with sloping sides too steep for the bird to stand on. He lined these sides with blotting paper and equipped the bottom of the arena with an inked stamp pad. When he put indigo buntings in this cage, they first stood on the bottom getting their feet well inked and then, as they became restless, they fluttered against the sloping

William O'Neill, a Stony Brook graduate student, prepares to release a pigeon equipped with a hood and translucent goggles that allow it to see only vague shapes.

O'Neill tracks a bird, using radio equipment packed into the back of a car known as the pigeonmobile.

sides of the arena, leaving little inky footprints. All Emlen had to do was cover the cages with a screen or a piece of plastic, put them out under the night sky, and then look for the direction of the footprints. A remarkable improvement over spending the night on one's back counting bird hops—and no computers needed!

Using this technique, Emlen has confirmed Kramer and Sauer's major point: that indigo buntings, at least, can use the stars to choose a direction. But migration involves more than simply flying in a specific direction. Many times birds are blown off course by crosswinds, and if they are to return to their original breeding ground, they must compensate for this displacement. The bird must first determine where it is in relation to its goal, in this case, its breeding ground. Having determined this, it can now choose a new compass course to get there. This concept of a two-step system was described by Kramer as a "map and compass" system; the "map" was the process of locating oneself relative to the goal and the "compass" was the directional cue, like the familiar magnetic compass, used to keep to the chosen course.

Put yourself in the position of the bird. You suddenly find yourself over an expanse of open water. Your compass tells you which way north, south, east, and west are, but before that will do you any good, you have to know where you are in relation to where you're going. Is it the Atlantic, Pacific, or Indian Ocean? Or is it a great lake? This question has to be solved before a compass can help. This process, which Kramer called map, is also known as true navigation. Once you have determined that home is west, a compass is very useful for flying in that direction.

The bird that has been blown off course must then have some way of navigating and thereby correcting its compass course for home. The obvious suggestion was that this process was also accomplished using the stars. This idea is easy to test in a planetarium: one can simply display the star pattern that would be seen from a place east or west of the bird's normal migration route at any given time and note if the bird alters its heading or the direction of its inky footprints to compensate for the apparent displacement.

Sauer reports that this is exactly what happened in an experiment using European warblers; the birds did, in fact, alter their compass heading to correct for the apparent displacement. Emlen, however, has not been able to show this in indigo buntings. The buntings keep their

same headings no matter how far east or west the sky pattern has been moved. It seems, then, that at least some species of night-migrating birds can and do use the stars as a compass; whether they can also use them as a map to navigate by is less clear.

But even if birds do use the stars, this cannot be the whole story. A lot of migration occurs on cloudy nights. And by using radar it has been possible to follow flocks of migrating birds even under overcast conditions. Such studies have shown that birds are well oriented under an overcast, and some recent observations suggest that birds are oriented even on the rare occasions when they fly within the clouds themselves. Clearly the birds must have alternative methods of navigation, and when one cue is taken away they must be able to switch to some other strategy. It is probably a serious mistake, therefore, to search for *the* way in which birds navigate; most likely there are many different sources of navigational information. It would be nice, though, to know what they are using to find their way in the middle of the night, inside a cloud.

A student working as a pigeon tracker prepares a lunch while listening to a pigeon's radio beacon on his earphones.

Lee R.G. Snyder, now at Stanford, watches a pigeon successfully take off after being held in the water. The question was whether a pigeon released at sea could take off again if it landed in the water.

Many problems arise in working on migratory birds. In the first place, migration only occurs for a month or two in the spring and fall. This means a frantic period of investigation, then a long wait until the next season. Secondly, it is hard to do experiments on freely migrating birds. William Cochran at the University of Illinois equips thrushes with small radio beacons and then waits, often for several days, for the radio-equipped birds to decide to migrate. Emlen has found he can often persuade birds to migrate by sending them up in balloons and releasing them at several thousand feet. Short of such ingenious and heroic procedures, migratory birds are hard to work with. What one would like is the white rat of the bird world, and to a large extent the homing pigeon fits that role.

The homing, carrier, or racing pigeon—a relative of the common street pigeon—has been bred for generations to return rapidly to its home loft when released away from home. Today they are still raced for sport. In a major pigeon race the fastest bird home may win several hundred dollars for its owner; not surprisingly, there is intense competition to breed and train the fastest possible birds. From the standpoint of understanding bird navigation, homing pigeons are almost ideal. They work all year long; they return to the investigator's loft, so that each bird can be used many times; they are easy to handle and are nice and big, so that one can attach all sorts of instruments and the birds can still fly. Their only drawback is that they don't migrate.

At the same time, homing pigeons routinely do what a migratory bird that has been blown off course does—a pigeon taken from its loft and released at some place where it has never been before will usually circle once or twice and then head for home. It must, therefore, have some way of determining the direction to the home loft. It must be able to navigate. This ability has attracted many investigators, and the literature of experiments on pigeon

An airplane follows a pigeon over Ipswich, Massachusetts. The plane flew much faster than the pigeon, and since the experimenters did not want to scare it or herd it in any direction, the plane approached only to within a half-mile of the bird, turned and flew in the opposite direction for three minutes, then turned again and flew back toward the pigeon. This system produced an accurate position for the pigeon every six minutes.

Birds were taken aboard this chartered boat from Provincetown, Massachusetts, and released 40 miles out at sea to insure they had no landmarks to help their navigation. They were then tracked by boat and plane. Martin Michener, at top, and two assistants are installing the antennas used for tracking.

navigation is huge. In spite of this enormous amount of work, when Martin Michener and I began our research in 1962, we found that little information existed about what an individual pigeon does between the time it is released and the time it arrives at the home loft. Flocks of pigeons had been followed by airplanes, but because the pigeon is a highly social bird, it is reluctant to fly alone, and the path of a flock must represent some consensus of the orientation of its members.

Michener's idea was to follow individual birds on their homing flights, and to do this he built small radio transmitters that the pigeons could carry. My part of the scheme

A pigeon named Blue 70 pushes through one-way bars as it returns to the loft after a flight.

This pigeon is equipped with coils of wire that produce a uniform magnetic field around its head. The pack on its back contains batteries for the coils and the radio beacon used for tracking.

A pigeon outside the loft gazes at itself in the mirror. The mirror reflects the sun's image onto a second mirror that can be tilted; thus, to birds inside the loft, the sun can be made to appear higher or lower in the sky than it really is.

was to learn to fly an airplane so that we could follow a transmitter-equipped pigeon wherever it might roam. We had our share of problems in getting airplane, radio, trackers, and pigeons all to cooperate. On one of our first flights, all went well until the pigeon decided it had flown enough and sat down on the telemetry antennas at M.I.T.'s Lincoln Laboratories. Our transmitters are very low power, but placed directly on an ultrasensitive antenna, they become rather strong. Lincoln Laboratories, however, is a restricted area so we could not get close enough to throw a rock at the pigeon to persuade it to move on; all we could do was wait. When it eventually flew off, we dashed for the airplane and managed to track it toward the loft, whereupon it promptly landed again—this time on the grounds of a mental hospital. After some discussion we agreed that it didn't seem wise to wander around the hospital grounds with our portable radio-direction finder—we could easily imagine the discussion with a guard if we said we were looking for our pigeon.

Actually, the pigeon-tracking radio system worked remarkably well—we could follow a single bird for days if need be. Frequently we would leave a bird roosting at night and find it in the same place before daybreak the next morning. In this way we learned a great deal about the behavior of individual pigeons. One of the first things we learned was that pigeons are either not familiar with the federal air traffic regulations or they choose to ignore them. Our birds were just as ready to fly over Boston's Logan Airport as anywhere else. When we radioed the radar approach control that we wanted to enter their control zone to follow a pigeon, there was usually a long moment of silence while the controller no doubt wondered if somebody was pulling his leg or whether there really was some nut up there following a pigeon.

Following birds that were released from places where they had been many times before, we found they took similar but not identical routes home each time. They were not simply following a set sequence of landmarks to the loft. Furthermore, their track was no more irregular on days with poor visibility than on days when you could see for miles. Nor were the birds blown off course by crosswinds. In fact, they only seemed bothered when the sun was obscured. Then they would stop flying and sit, frequently for hours, while we circled overhead in the airplane.

Next we took the birds south to New Bedford, Massachusetts, a place they had never been before. If the pigeons were using landmarks, we expected that when they were released in a new place they would search for something familiar. If they were simply using a compass and flying in the direction that had gotten them home from their training point west of the loft, they should fly east. But if they were really navigating, they should fly directly home, in this case, north. We found that all three things occurred; pigeons often would start out in their trained compass direction, then switch to navigation and head for the loft, and finally appear to use landmarks to find the loft itself. But there was great individual variation in strategies—some pigeons always flew an initial compass course; others never did.

One of our birds, B77 (a blue band, No. 77) always flew directly home. Another bird, WY, was trained along a route that had a prominent hill on the way home. Released in a new place, it invariably flew to the nearest mountain, then turned and headed for home.

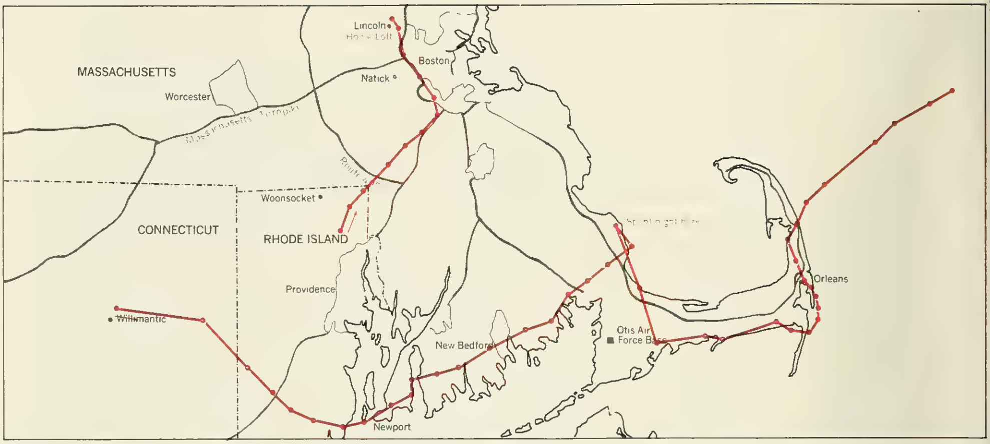
The point is simply that pigeons are individuals, and they clearly use a variety of strategies. Following individual birds gave us an insight into what each bird was likely to do; then when we gave the same birds some experimental treatment, we could recognize any changed behavior.

Our first idea was that the birds were using the sun. It had been known for a number of years that pigeons can use the sun as a compass and can compensate for the sun's apparent movement through the sky by using an internal clock. But two Englishmen, G.V.T. Matthews and C.J. Pennycuick, suggested that the navigation, or map, might also be based on the sun. They proposed that a pigeon might compare the sun's position where it was released to its memory of the sun's position at the home loft at the same time of day. From this comparison, the pigeon could determine the direction to the loft. This was an appealing idea not only because it is somewhat similar to what human navigators do but also because it made specific predictions that could be tested. For example, a pigeon that had been released north of its loft would see a sun at noon that was lower in the sky than the home sun at noon. Similarly, for a pigeon released south of the loft, the noon sun would be higher in the sky than at the home loft. Of course, because pigeons navigate at all times of day, not just at noon, they would have to have a way of estimating the sun's noon altitude at any time of day, but let's ignore this complication for the moment.

To test this idea, Michener and I arranged a small cage in a corner of the loft. From this cage the only view of the outside world was through a window, the bottom half of which gave a view of the field in front of the loft and of the lower part of the sky. The top portion of the window showed the pigeon the sky's upper region and allowed it a view of the sun for about three hours centered around noon every day. We hoped the pigeons did not notice that their view of this top part of the sky and sun was seen through a pair of mirrors. By adjusting the angle of one of the mirrors, we could make the sun appear either too low or too high in the sky. In short, we could make it appear to a pigeon, attentive to the sun's altitude at noon, that the loft had been moved either north or south.

We exposed pigeons to this "mirror box" for ten days to two weeks, then released them in a place they had never been before. If they "believed" what the mirrors had shown them, we expected them to fly toward the place where the sun really behaved as it appeared to in the mirror box.

Unfortunately, the pigeons simply flew home.



Colored lines represent tracks of pigeons trained to home to the same loft; points on the tracks are accurate locations. The lower track indicates the path of a pigeon, released in Willimantic, whose compass clock had been shifted by six hours; it generally flew 90 degrees to the right of the course home. The upper track is that of a pigeon, released near Woonsocket, whose clock had been shifted by only five minutes; it flew more or less directly back to the home loft.

Then we wondered if the pigeons had homed normally because the mirrors had not, for some reason, fooled them. This being possible, we switched to a more radical form of treatment: we began to upset the pigeon's internal clocks. A bird that is using the sun for navigation must have an accurate clock to determine whether it has been displaced east or west of home. If a pigeon determines north–south displacement by noon sun altitude, it might use what is, in effect, a comparison of sunrise times to determine its east–west position. Suppose a pigeon notices that the sun rises at 6:00 A.M. in its home loft in Lincoln, Massachusetts. Now the pigeon is displaced and sees a sun that is not as far along its path, indicating a sunrise time of 7:00 A.M. Obviously, such a bird is west of the loft, and must fly east to get home.

The bird could use the time when the sun reaches its highest point in the sky, the noon position, in the same way. The time of sunrise or of local noon varies about four minutes for every fifty miles you travel east or west. If you go from Boston, Massachusetts, to Albany, New York, you will notice that both the sunrise and the local noon are eight minutes later in Albany. Normally, we ignore such differences until they reach about an hour; then we call them time zones. They are about 750 miles wide.

A number of people have shown that if a pigeon is put in an artificial environment where the lights go off and on out of phase with the real day, its internal clock will gradually shift to the new time schedule. Thus, if sunrise and sunset are 6:00 A.M. and 8:00 P.M., respectively, but the lights in the box go on at 7:00 A.M. and off at 9:00 P.M., the pigeon has experienced a normal day length, but is shifted one hour out of phase—its internal clock is one hour behind local time. And there is, in fact, a place where the sun altitude is the same as at the loft, but the local sun time is exactly one hour behind. Such a place would be 750 miles west of Lincoln, or near Chicago, Illinois. If a pigeon were navigating by the sun, it might well home to this place rather than to the loft.

To test this idea we used pigeons with clock shifts of 0, 5, 10, 15, 20, 60, 120, and 360 minutes, and then released and tracked them from places they had never been before. All except the birds with the 360-minute (six-hour) shift homed normally. The birds with the six-hour shift headed in every direction.

That birds with a six-hour clock shift show poor homeward orientation is not surprising when you remember that pigeons also use the sun as a compass. Since the sun moves 15 degrees an hour, a bird with a six-hour error in its clock should make a compass error of 90 degrees. Klaus Schmidt-Koenig in Germany has shown that this is exactly what happens. Suppose you want to fly east. The real time is sunrise, 6:00 A.M. Your internal clock says that the time is six hours later, namely, noontime. To fly east at 6:00 A.M., you fly roughly toward the sun, but because your clock tells you it is really noon, you know the sun is in the south and that to fly east, you must fly 90 degrees to the left of the sun. And this is exactly what the birds do, although presumably they do not go through the rea-

soning process I have described.

Our clock-shift experiments seem to have affected the birds' sun compass, but to have had absolutely no effect on their navigation. In desperation we considered the possibility suggested by Klaus Hoffmann—that the birds might have two clocks. One of these would be a "sun compass clock," easily set to local time; the other a "navigation clock," highly resistant to resetting.

This idea led us to perform a really radical experiment. It has been found that heavy water, in which the hydrogen atoms have extra protons in their nuclei, slows down all biological clocks on which it has been tested. Lee Snyder found that 30 percent heavy water in drinking water slowed down the activity rhythms of pigeons by about 6 percent. We took a group of experienced pigeons, put them in a clock-shift box where the lights came on and went off at irregular intervals, and gave them 30 percent heavy water to drink for about two weeks. At the end of this time, their internal clocks should have been thoroughly scrambled. But we could not just take these birds out and release and track them. Their sun compass clocks would also have been upset and it would be impossible to say whether our treatment had affected their map or only their compass.

Instead, we transported the birds in a closed container to Ithaca, New York, about 250 miles west of Boston. William Keeton and Andre Gobert held the birds for us in an open cage where they had an unobstructed view of the sun. After ten days to two weeks in Ithaca, drinking normal water and with a view of the sun and a normal day, the pigeons should have reset their clocks to Ithaca time. Next we took all the pigeons to a spot between Ithaca and the home loft. If the pigeons' navigation clocks were set to Ithaca time and they were using the sun, they should fly west to Ithaca. If they were simply confused, which seemed the most likely possibility, they might fly in any direction. But if they weren't bothered by our treatment, they would fly home.

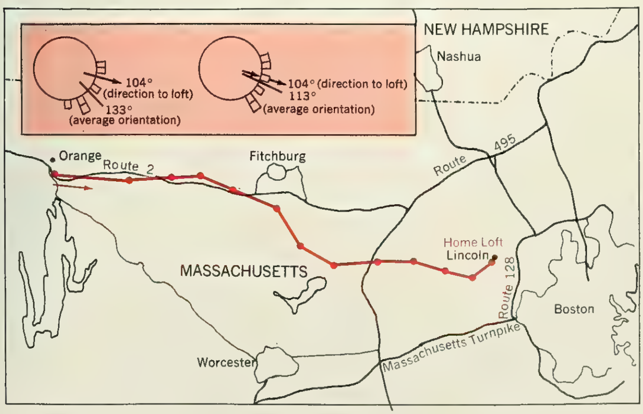
And that is exactly what they did. Their homeward bearings and tracks were even more accurate than those of pigeons just taken directly out of the loft. This result, together with Keeton's finding that his pigeons showed excellent orientation even under total overcast when they could not see the sun, leads us to believe that the sun is probably not the basis of pigeon navigation. At the very least, there is some other series of cues that pigeons can use to get home.

It occurred to us that the pigeons might be getting some information during the trip from the loft to the release site. Such a possibility seemed unlikely, but to test it we anesthetized the birds at the loft and drove them to the release point fully anesthetized, in a covered cage, and in a strong, fluctuating magnetic field. Such an experiment may seem to have too many variables, and indeed, that is the case. But if all of these treatments have no effect, then one has ruled out several possibilities at once. And that is exactly what happened: after the birds had recovered from their anesthesia, they homed just as well as the controls. This result indicates that the pigeons are probably obtaining their navigational information at the release site rather than during the trip out.

There is other evidence suggesting the same thing—each release site seems to have its own, characteristic error. That is, birds released at a particular point may not head precisely toward home. They may instead choose a direction as much as 90 percent from the correct home bearing. This error is consistent both from day to day and even for pigeons from different lofts.

Whatever it is the pigeons are using probably does not depend upon their ability to see. In a series of very exciting experiments, Hans

Here is the track of a pigeon that flew straight home despite attempts to confuse it. The bird had been subjected to random periods of light and dark and given heavy water to drink; then it was taken 250 miles west to Ithaca, N.Y., and kept there for 10 days. When released the pigeon flew straight home to its home loft in Lincoln, Mass. In the inset, the little boxes on each circle represents the directions taken by individual pigeons after being released in Orange, Mass. Circle at left shows the results for the control birds, whose average course on release was less accurate than that of the treated birds, whose initial flight directions are indicated on the right circle.



Schlichte and Klaus Schmidt-Koenig have shown that pigeons can home even when their eyes are covered with translucent contact lenses, which prevent them from seeing anything but a general, diffuse image of very close, large objects, rather like the view one gets of an approaching person through a ground-glass door. Because pigeons equipped with these lenses showed homeward orientation as accurate as that of birds equipped with transparent lenses, it seems unlikely that vision plays an essential role in pigeon navigation.

But if we eliminate vision, what is left? An obvious idea is that pigeons might somehow use some aspect of the earth's magnetic field. This is a very old idea, and the experiments of Henry L. Yeagley, a physicist at Dickinson College, for example, show no convincing effect of equipping pigeons with small magnets. Once again it was the work of Keeton at Cornell that showed that, under overcast conditions when the sun was not visible, pigeons equipped with small magnets showed poorer orientation to the loft than did birds carrying equivalent brass weights. Under sunny conditions there appears to be no effect when the birds are released close to the loft, but if they are released at greater than usual distances, the magnet-equipped birds are frequently disoriented, whereas the birds with brass weights are not.

With our birds I found no differences when the pigeons were released at 50 to 70 miles, but on two releases from 120 miles on sunny days, the magnet birds were completely disoriented, the brasses were not. There are, however, puzzling aspects to these experiments. For one thing, the results are variable; one day there will be a clear difference between the two groups; the next day there will be none. Secondly, the pigeons with magnets do not all seem to fly on a consistent bearing—they simply fly off in all directions.

It occurred to us that the field of a small bar magnet is restricted and, as the pigeon moved its head, the magnetic field around the head would vary greatly. Of course, there is no particular reason to believe that a pigeon's magnetic receptor, if it has one, would be located in the head. It might, for all we know, be in the left hind toe. But the head seemed a likely place to begin.

We equipped the pigeons with a pair of small coils and a battery. One coil was glued to the top of the pigeon's head like a hat, the other served as a collar around its neck. By changing the amount of current through the coils we could accurately vary the strength of the magnetic field around the head. We began with very weak fields, only 0.1 gauss (approximately 1/6 the strength of the earth's normal field of 0.6 gauss). Control birds carried the same apparatus, but the coil was not connected to the battery. The effect of this procedure was to increase the scatter of the directions that the experimental birds took, as compared to the controls. It appeared that this effect is relatively consistent: on 14 out of 19 releases the experimental birds were less well oriented than the controls.

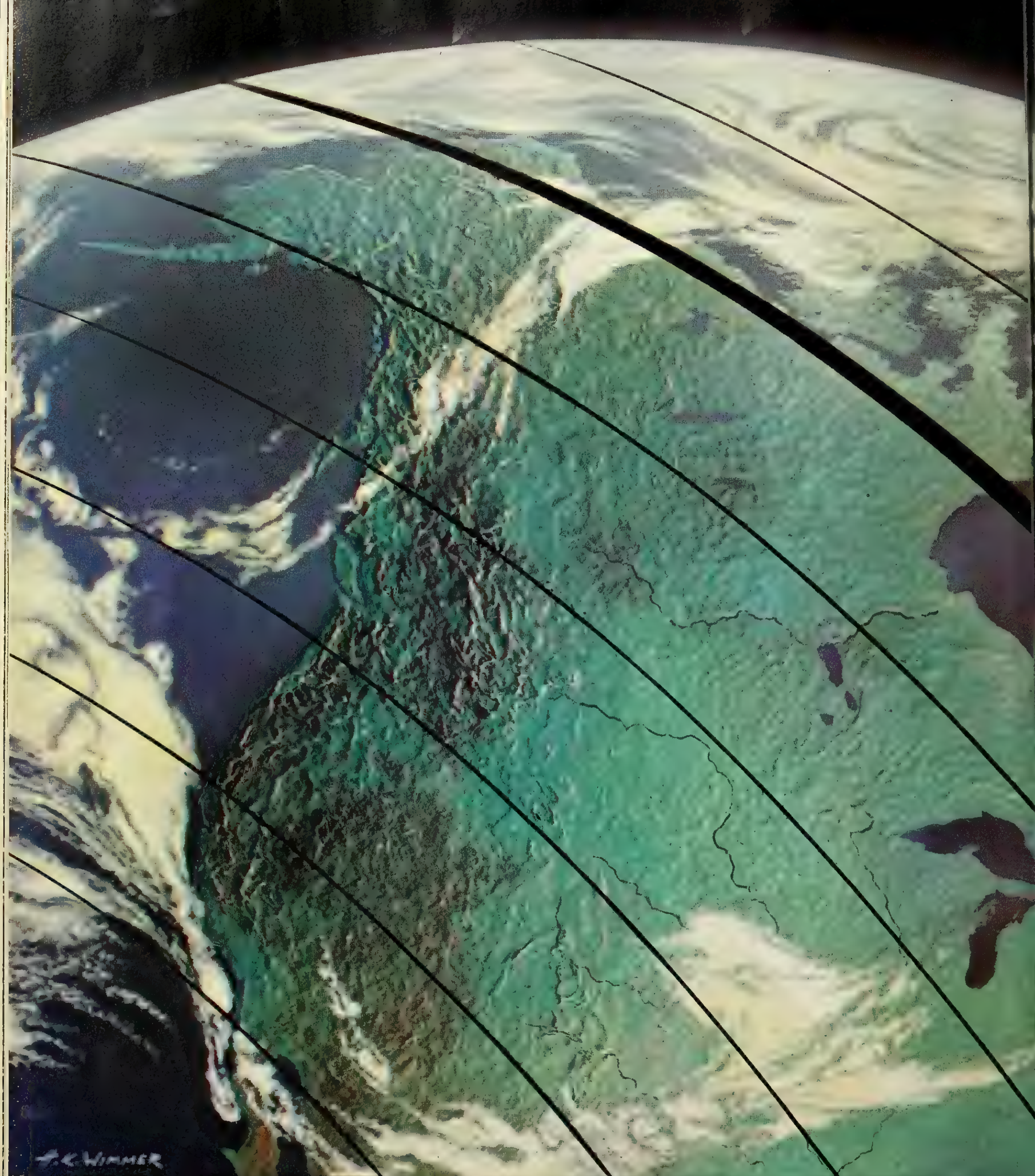
Most recently we have had a hint of an even more impressive effect. Robert Green, an undergraduate at the State University of New York at Stony Brook, made two releases of birds with coils designed to produce somewhat stronger magnetic fields (0.6 gauss), under overcast. His experimental and control birds were identically equipped with coils, except that ten birds had their batteries connected one way and eight had the battery connections reversed. The magnetic field of the coils was thus oriented one way for the first group and in the opposite direction for the second. That is, the north pole of the induced field was toward the bird's head in one set and toward its tail in the other.

When the two groups of birds were released and tracked from New York City, fifty miles west of the loft at Stony Brook, Green found that one group of birds flew directly east toward the home loft but that the other birds flew in an almost exactly opposite direction! While the number of birds used and the number of releases are not great enough to verify these results, they are exciting. If these experiments can be repeated, it suggests that an applied magnetic field can drastically upset a pigeon's orientation and that the effect of the field depends on its polarity. If by altering the direction of the applied magnetic field, we can make pigeons fly in predictable directions rather than simply flying home to the loft, it indicates that magnetic fields are in some way related to pigeon navigation. After repeated experiments, the differences probably will disappear—that seems to be one of the problems in working with pigeons. But they just might not, and it is that hope that keeps us going.

Suppose that we are successful and find that artificial magnetic fields do have an effect: Have we then found the basis of the pigeon's navigation? I suspect not. It is hard to see how a pigeon could use the earth's magnetic field to tell it where it is in relation to home. It seems much more likely that if the birds are using magnetic cues, they serve as an auxiliary compass to be used when either the sun or stars are obscured. Only further investigation will tell.

We are sure that birds use a wide variety of cues to migrate or home over the surface of the earth. Migrating warblers use the stars as a compass, and pigeons use the sun. No doubt both can use landmarks. But how they navigate is still unknown. And in a way that's rather nice. Here is a problem that many people have worked on for a great many years; we have all seen the phenomenon, it is all around us. But the birds won't tell—at least not until we ask the right questions.

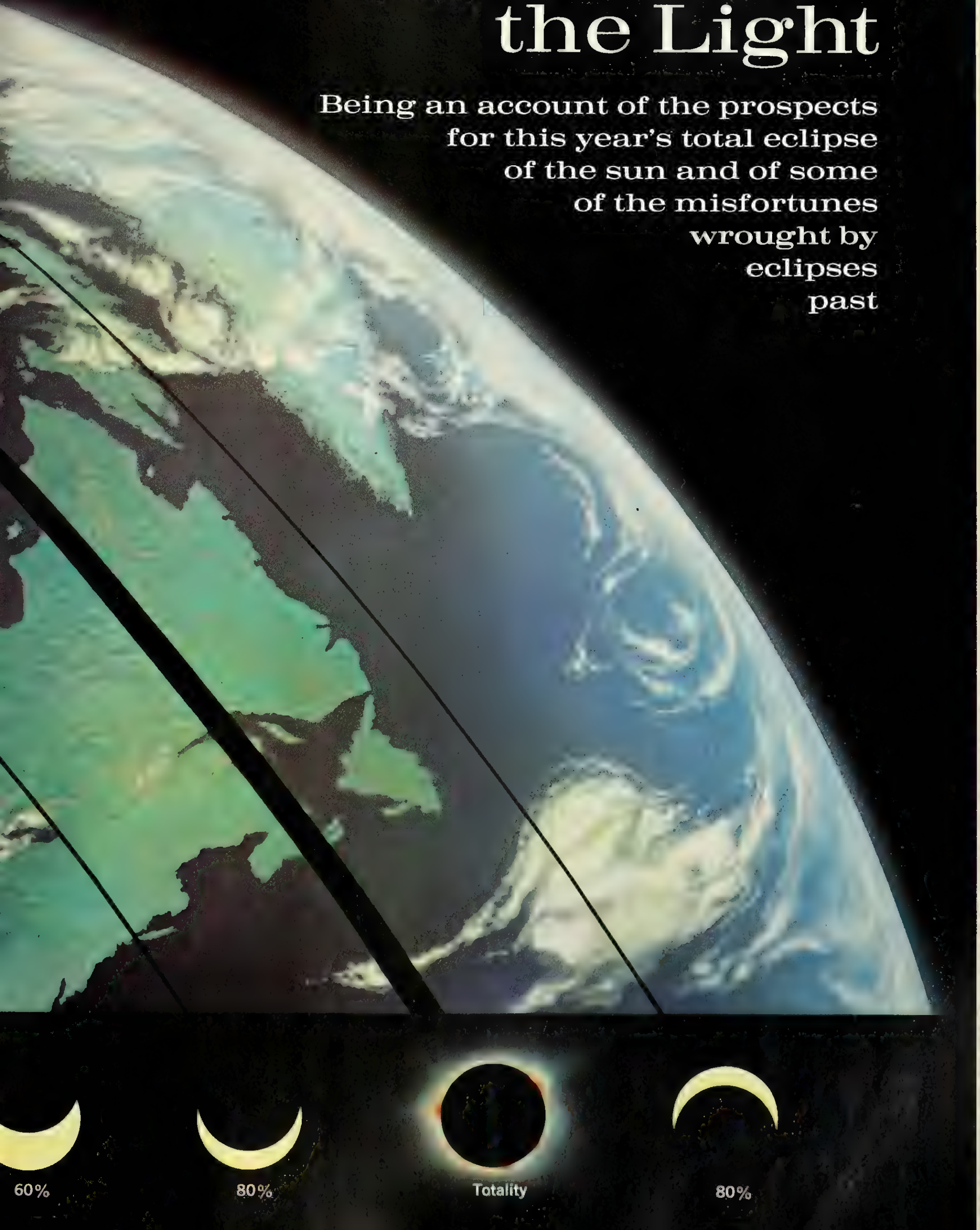
A flock of pigeons rests on the loft roof after a training flight. Birds are trained to home from increasing distances first in groups, then by themselves. When they routinely return alone from 50 miles, they are ready for experimental use.



The sun will look like these symbols on July 10. The lines leading to them show how much of the eclipse will be seen from various parts of North America.

Turning Out the Light

Being an account of the prospects for this year's total eclipse of the sun and of some of the misfortunes wrought by eclipses past



The Where, When, and Hov

by Thomas D. Nicholson

The month of July brings two eclipses to North America, one solar and one lunar. The solar eclipse on July 10 will be total in parts of Alaska and Canada, partial elsewhere on the continent. The lunar eclipse, on the night of July 25–26, will be partial, visible generally throughout North America. With the eclipses of last January (one an annular eclipse of the sun, the other a total eclipse of the moon), these two July events will complete the eclipse calendar for 1972. More importantly, the July 10 event will be the last total solar eclipse that can be seen in or near the United States for 45 years.

Many *Natural History* readers will remember the March 7, 1970, solar eclipse, which was total along a path extending from Mexico across the central gulf coast to the mid-Atlantic coast and partial elsewhere in the nation. The path of totality crossed easily accessible regions of the southeast, with good roads and accommodations for travelers, and weather prospects were fair to good. Many readers traveled to the parts of Alabama, Georgia, the Carolinas, and Virginia where the eclipse was total. Those who chose observing sites farther south were disappointed by thick clouds preceding a cold-front passage. Those who went north to Virginia, where the cold front had already gone by, found ideal observing conditions and a beautiful eclipse. Observers had been alerted to expect that kind of fast-moving weather circumstance in 1970 and to be ready to move quickly if they wanted to enhance their chances of seeing the total eclipse.

Now, on July 10, we will all have another chance. This time the path of totality crosses the eastern Soviet Union, northern Alaska and Canada, then curves south across Hudson's Bay, Quebec, and the Maritime Provinces. The total eclipse path, in Quebec, New Brunswick, Prince Edward Island, and Nova Scotia, again includes easily acces-

of the July 10 Eclipse

sible areas with good roads and good travel facilities. Furthermore, this is delightful vacation country, with enough charm to attract the summer visitor in any year. The added attraction of a total solar eclipse should make southeastern Canada popular indeed.

For those who stay home or vacation elsewhere on July 10, the accompanying illustration shows what can be expected. In southern Canada and in the United States (except for part of Alaska), the eclipse will be partial, and the portion of the sun that will be obscured by the moon will decrease from north to south and from east to west. More than 90 percent of the sun will be obscured at mid-eclipse in Maine, but in Los Angeles the moon will cover less than 10 percent of the sun's diameter. The eclipse occurs in the early afternoon on the Pacific Coast, in the late afternoon along the Atlantic seaboard. The duration of the eclipse, the time of mid-eclipse, and the magnitude, or percent of the sun's diameter covered at mid-eclipse, at representative cities are shown in the accompanying table.

Where the eclipse is partial, the dark moon will appear first on the west (right) edge of the sun and move from right to left across the sun. It will take from half an hour to an hour or more, depending on location, for the moon to reach mid-eclipse, when the maximum amount of the sun's diameter will be covered, leaving part of the sun visible below the southern (lower) edge of the moon. Another half an hour to an hour or more will be required for the moon to move off the east (left) edge of the sun.

SOLAR ECLIPSE JULY 10

	Eclipse Begins	Mid-eclipse	Magnitude	Eclipse Ends
New York (EDT)	3:33 P.M.	4:42 P.M.	80%	5:45 P.M.
Pittsburgh (EDT)	3:27 P.M.	4:38 P.M.	71%	5:42 P.M.
Atlanta (EDT)	3:40 P.M.	4:47 P.M.	51%	5:47 P.M.
New Orleans (CDT)	2:48 P.M.	3:48 P.M.	34%	4:42 P.M.
Chicago (CDT)	2:15 P.M.	3:28 P.M.	63%	4:34 P.M.
Kansas City (CDT)	2:14 P.M.	3:24 P.M.	48%	4:28 P.M.
Bismarck (CDT)	1:47 P.M.	3:01 P.M.	59%	4:11 P.M.
Salt Lake City (MDT)	12:45 P.M.	1:49 P.M.	31%	2:51 P.M.
Denver (MDT)	12:58 P.M.	2:05 P.M.	36%	3:08 P.M.
Seattle (PDT)	11:13 A.M.	12:21 P.M.	44%	1:30 P.M.
San Francisco (PDT)	11:40 A.M.	12:26 P.M.	14%	1:12 P.M.

But the prize of the event is reserved for those who visit the path of total eclipse. No one who has seen such an event will ever forget it. Anyone who has not yet experienced it will find it well worth the effort. The sudden darkening, the swift sense of chill, the rapid changes in the sun's appearance, the sight of stars by day, the strange color of the remaining light, all add to an excitement that builds swiftly to a climax as the sun's corona appears like a halo around the dark moon at totality.

For astronomers, however, July 10 is not a particularly exciting eclipse. The sun will be low in the afternoon sky in eastern Canada, and the total eclipse will be relatively short in duration, slightly more than two minutes. The weather outlook, based on climatic records for the area, is not too promising. Professional astronomers are looking forward to the June 30, 1973, eclipse, when totality will last more than seven minutes and the sun will be high in clear atmosphere. But that will be visible from the Sahara Desert in Africa. Unless we can follow astronomers to remote parts of the world, the July eclipse will be our best opportunity for a generation.

The low sun and short period of totality will not bother the nonprofessional viewer, nor will it dampen the excitement and beauty of the event. But weather is the real culprit. Climate records over eastern Canada for early July place the odds against seeing the total eclipse at about two to one. The problem is the typical buildup of late afternoon cumulus clouds over land areas on what might otherwise be a pleasant summer day.

Climate data for the area were reviewed by John W. Stewart of the University of Virginia in *Weatherwise*, a journal of the American Meteorological Society. Chances for clear skies during the eclipse are 10 to 20 percent, for partly cloudy skies about 30 percent, and for overcast skies (80 percent or more cloud cover) 50 to 70 percent. According to Stewart, the best opportunities for seeing the eclipse will be found on the north coast of Quebec's Gaspé Peninsula, where afternoon cloudiness is less likely to form over the wide St. Lawrence estuary than it is over land areas, and where the viewing direction to the sun at totality will be over water. A similar advantage could be claimed for locations on the coast of Prince Edward Island and the north coast of Nova Scotia. But climate records give little advantage to any location in the Maritimes, and any differences in climate data may well be

This more detailed map shows the path of totality across eastern Canada. The times indicated are the times of mid-eclipse at each position.

far less significant than the weather that actually occurs on July 10.

Travelers should be alert to special eclipse forecasts that will be made by the Canadian Atmospheric Environment Service. Because of the bodies of water between the land areas over which the moon's shadow passes, it will not be so easy to change location quickly and significantly this time. Nevertheless, weather advisories a day or so before the eclipse might suggest some preferences along the nearly 450-mile-long and 110-mile-wide path of totality from the north shore of the St. Lawrence to the south shore of Nova Scotia.

Readers seriously concerned with analyzing the climate records may wish to obtain *Climatic Data for the Day of the Eclipse July 10, 1972*, by F. D. Manning, Publication CDS #6-70, Canadian Atmospheric Environment Service, Ottawa, Canada. And if you plan to combine a vacation trip with your eclipse expedition, you may want to write to the Canadian Government Travel Bureau, 680 Fifth Avenue, New York, N.Y. Those who plan to photograph the event (either total or partial) should obtain *Solar Eclipse Photography for the Amateur*, Eastman Kodak Company, Rochester, New York. This booklet will also advise what precautions you should take to avoid eye damage while viewing an eclipse. These precautions are equally important whether you are observing from within the path of totality or from some location where the eclipse will be partial.

There is no risk of eye damage during the total phase of an eclipse. When the sun is completely covered by the moon, only the much fainter light of the sun's chromosphere and corona (atmospheric layers in the sun) is visible. But when the sun is only partly covered by the moon, before or after totality, or at any time during a partial solar eclipse, the portion of the sun's surface that remains visible has the same brightness it has under normal conditions. Prolonged viewing of this uncovered area of the sun's surface, or viewing for any period—no matter how short—with optical aids such as binoculars or camera rangefinders, can permanently and irreparably damage vision unless adequate protection is used. The sun's rays are no different and no more harmful during an eclipse than they are at any other time, but they are also no *less* harmful. And that is the point. During an eclipse, we may be tempted to look at the sun longer or in different ways than we normally would. We should be sure that we are doing so safely.

There are safe ways of viewing the sun during an eclipse—or at any time. We could, for example, see it reflected in a pool of water. Or we could project it on a white screen or cloth through the lens of a telescope or binoculars. Or we could use com-

Eclipses: A Literature of Mi

by Sam Silverman and Gary Mullen

Scientific papers almost invariably give the impression that no problems, other than technical ones, enter into an experiment. The typical scientific paper is designed to present a picture of a logical continuity from conception to conclusion; of precision and efficiency at every step of the way, tempered only by the difficult obstacles that a sometimes refractory nature puts in our way. The eclipse literature is almost alone in the physical sciences in affording glimpses of other factors, including human ones, that affect the outcome of a scientific measurement. Some excerpts from the literature illustrate these problems.

Our first selection, taken from Plutarch, illustrates the interaction of society and the scientist or, perhaps more accurately, the impact of society on the scientist. The occasion was the lunar eclipse that led Nicias of Athens to delay his retreat and resulted in a major defeat of his forces by the Syracusans.

> And when all were in readiness, and none of the enemy had observed them, not expecting such a thing, the moon was eclipsed in the night, to the great fright of Nicias and others, who, for want of experience, or out of superstition, felt alarm at such appearances. That the sun might be darkened about the close of the month, this even ordinary people now understood pretty well to be the effect of the moon; but the moon itself to be darkened, how that could come about, and how, on the sudden, a broad full moon should lose her light, and show such various colors, was not easy to be comprehended; they concluded it to be ominous, and a divine intimation of some heavy calamities. For he who the first, and the most plainly of any, and with the greatest assurance committed to writing how the moon is enlightened and overshadowed, was Anaxagoras; and he was as yet but recent, nor was his argument much known, but was rather kept secret, passing only amongst a few, under some kind of caution and confidence. People would not then tolerate natural philosophers, and theorists, as they then called them, about things above; as lessening the divine power, by explaining away its agency into the operation of irrational causes and senseless forces acting by necessity, without anything of Providence or a free agent. Hence it was that Protagoras was banished, and Anaxagoras cast in prison, so that Pericles had much difficulty to procure his liberty; and Socrates, though he had no concern whatever with this sort of learning, yet was put to death for philosophy.

The sun and the moon have always been important in human life. The moon, in particular, has played

LUNAR ECLIPSE JULY 25-6	Eclipse Begins	Mid-eclipse	Eclipse Ends
Eastern Daylight Time	July 26; 1:55 A.M.	July 26; 3:16 A.M.	July 26; 4:36 A.M.
Central Daylight Time	July 26; 12:55 A.M.	July 26; 2:16 A.M.	July 26; 3:36 A.M.
Mountain Daylight Time	July 25; 11:55 P.M.	July 26; 1:16 A.M.	July 26; 2:36 A.M.
Pacific Daylight Time	July 25; 10:55 P.M.	July 26; 12:16 A.M.	July 26; 1:36 A.M.

mercially available sun filters or prepare special filters as instructed by Eastman Kodak in the booklet named above. But never try to look at the sun through ordinary sunglasses, through smoked glass, through colored glass such as soft-drink bottles, or through ordinary exposed film negatives.

The second eclipse of July, the partial lunar eclipse, occurs when the lower (or southern) half of the moon brushes through the earth's shadow on the night of July 25–26. Beginning before midnight on the West Coast and occurring mostly after midnight on the East Coast, the eclipse will reach maximum when the earth's shadow covers about 55 percent of the moon's disk. Flat-earth theorists may not be anxious to watch at that time, because the earth's shadow on the moon will be curved, just as it should be if cast by a spherical object. Events during the eclipse will occur as shown on the schedule above.

Of the two July eclipses, the solar eclipse on the 10th is by far the more interesting. But the lunar eclipse is the easier to see: If the sky is clear, all you have to do is go outdoors. One observing location has no advantage over another. As for the solar eclipse, admittedly you will have to travel to eastern Canada to see the total eclipse, and even there you will have to locate precisely. You will also have to take your chances with the weather, with odds about two to one against you. But if you miss this one, you have a long time to wait for the next, unless you can travel much farther away from home. Not until August 21, 2017, will there be another total solar eclipse within easy reach of the continental United States.

dventures

a significant symbolic role. The waxing of the moon has meant life and growth; its waning, death and decay. Perhaps for this reason a lunar eclipse occurring at the full moon, which divides life and death, had a portentous meaning that usually signified disasters of one sort or another; hence, the importance of the event itself and of its foreknowledge. If one cannot avert disaster, then the next best thing is to be prepared for it, and to be prepared one must be able to predict. Those entrusted with this function bear a heavy responsibility. The consequences of failure to do this are illustrated by the probably apocryphal story of the first recorded eclipse in Chinese annals.

> Hi and Ho, steeped in wine, were not able to make any use of their talents. Without any regard for the obedience they owed to the prince, they abandoned the duties of their post, and they were the first who upset the good order of the calendar, which had been entrusted to their care; for on the first day of the last moon of autumn, the sun and the moon in their conjunction were not in accord in Fang, a blind man was striking a tambourine, officers were mounting horses, and people were running up. During this period Hi and Ho, like statues of wood, neither saw nor heard anything; and through their negligence to realize, and to see the movement of the heavenly bodies, they violated the law of death set up by our ancient princes. According to our inviolate laws, the astronomers who advanced or delayed the time [of the eclipse] were, without fail, to be punished by death.

Typically, however, eclipse observations are more troubled by species other than human, or by inanimate nature. A good example is the eclipse seen in Southeast Asia on May 9, 1929.

> In the week before the eclipse they had five inches of rainfall in five days, so that it is not surprising that they had complete humidity (estimated at about 100 percent), and we can imagine what the ground was like in a flat country of heavy clay. The observers discussed the advisability of cutting drains radiating from the camp, similar to the canals of Mars, but a discussion whether they would take water into the camp or out of it arrived at no very satisfactory conclusion. They had unexpected opportunities of observing animal life, since the pits dug for the clock-weights of the coelostats filled with water, which in some way produced a number of frogs. Other animals which came under observation were snakes, crocodiles, and iguanas, and millions of scorpions and centipedes. I believe that at the Indian eclipse of 1898 it was so dusty that Prof. Campbell flooded his darkroom floor in order to restrain the dust as much

as possible. On the recent occasion there was no dust, but the darkroom floor was flooded all the same—indeed, a good deal more so. There was scarcely any need to dissolve the hypo in water, for it soon dissolved itself if exposed to the air, and plates which had not been fully washed free from hypo would not dry at all. Work in the darkroom could only be conducted in short shifts, as it was necessary to come out to breathe, and the alternative of working at night in the open was subject to risks from lightning flashes, which occurred every evening. Besides the English expedition, there was an American party, who had diverted from the pursuit of big game to that of the eclipse.

Water, in the form of rivers, lakes, and clouds, was also responsible for what must have been one of the most frustrating and discouraging eclipse expeditions ever reported. The occasion was the eclipse of June 18, 1860, and the place was what is even today the sparsely settled regions of Saskatchewan, Canada.

> The remainder of the route of the expedition was down the Red River about twenty miles to the lake, through the lake to the mouth of the Saskatchewan, and then up the Saskatchewan to Cumberland House, in all about 550 miles. The country after leaving the Red River settlement, is a desolate and uninhabited wilderness, abounding in marshes and tamarac swamps, with a few limestone bluffs along the western coast of the lake. A few encampments of migratory Indians, obtaining a miserable subsistence from fishing, were the only inhabitants seen. A voyage on Lake Winnipeg in a frail canoe of birch bark, when it is stormy, is considered dangerous, especially the making of traverses of ten or twelve miles, of which there are a great many, and as the party had an unusually stormy time, and a rather frail canoe heavily loaded, it was very much detained on the voyage by the wind and waves. The party was fourteen days in going the length of the lake from Red River to the mouth of the Saskatchewan, and during the whole time it was enabled to proceed only one entire day without interruption, and was obliged to spend three consecutive days and nights on a small island in the lake on account of a long continued and violent storm.
>
> On arriving at the mouth of the Saskatchewan it was found that the river was never known to be higher, and that the ascent over the rapids and up the current the whole distance to Cumberland House would be unusually difficult. Only a little more than four days were left; yet the party still hoped to be able to accomplish it against the time of the eclipse. The crew labored very hard in ascending the rapids, being obliged at some places to drag the canoe along close by the shore by means of ropes, taking first only one half of the baggage and then returning for the other half, and at other places to exert the utmost of their strength with long poles in getting it past high and steep bluffs and rocks projecting into the current, so that two days were spent in making the Grand Portage, and ascending some eight or ten miles of rapids near the mouth of the river. The party now despaired of being able to reach Cumberland House in time for the eclipse, but still had hopes of being able to get within the limits of total darkness. After passing through Cedar Lake, the whole country for nearly a hundred miles was overflowed by the water of the river, so that the party could find no dry spot to stop upon but were obliged to cook with a fire made amongst the roots of large floating trees, and eat and sleep in the canoe.
>
> In order to get, if possible, within the limits of total darkness to observe the eclipse, the crew were persuaded to paddle up the river for thirty-six hours without stopping for sleep or rest, but late in the evening preceding the eclipse the party had been able to get only to the mouth of Moose River, a few miles only within the limits of total darkness. It was now very cloudy and rainy, and the strength of the crew was exhausted so that the party could do no better than stop and make preparations for observing the eclipse from this point, if by chance it should be visible next morning. It was, however, still raining in the morning and continued very cloudy until after the beginning of the eclipse, so that it could not be observed.

The presence of clouds at the crucial moments of totality is a recurrent problem of eclipse measurements, although in recent years the use of airborne instrumentation has obviated some of these difficulties. The possibilities of airborne measurements were recognized in the nineteenth century. Balloons as platforms had achieved considerable publicity after their use by the French during the siege of Paris in 1870, and a number of governments, including the Russian, set up balloon corps in recognition of the potentialities of airborne observations and weapons delivery. It was perhaps natural, then, that the eclipse of August 19, 1887, whose path spanned the Russian Empire from the Baltic Sea to the Sea of Japan, became the occasion to attempt an airborne observation of the eclipse. The scientist chosen to make the ascent with the army's principal aeronaut, Lieutenant Kovanko, was none other than Dmitri Ivanovich Mendelejeff, Russia's foremost chemist and discoverer of the periodic table. He was then 53 years old, not, as stated in the excerpt below, in his sixties. What actually happened during the attempt is somewhat in doubt, as will be clear from the following.

> At Klin, after a wet and cloudy night, patches of blue sky in the early morning raised delusive hopes, but during the eclipse the heavens were shrouded in dull gray, and a Scotch mist prevailed. To provide against that very contingency it had been arranged that Prof. Mendeleieff was to observe the form of the corona, its spectrum and the course of the moon's shadow from a balloon

A balloon carrying the Russian chemist Mendelejeff, but not the pilot, begins its ascent for the solar eclipse of August 19, 1887.

furnished by the Russian Imperial Institute of Technology, but the experiment was only partially successful. Partly because it was insufficiently filled with gas, and partly because it was waterlogged by exposure to a heavy dew which had fallen in the early morning, when after much delay the balloon was cast loose it refused to ascend. According to one account Lieut. Kowanko, the aeronaut who was to accompany Prof. Mendeleieff, thereupon got out of the car to make some necessary alterations, but on being relieved of his weight the balloon suddenly rose, and amid the hand-clapping of the crowd, the professor was carried away about two minutes before totality, begging his friends to collect his bones. Another account states that the professor—a man over sixty years old, who had never before been in a balloon—deliberately left the aeronaut behind him because the balloon could not carry both. Be that as it may, the balloon shot rapidly through the fog into the clear upper air, where, at an altitude of 11,500 feet, the professor had an excellent view of the corona, and saw the moon's shadow passing through the clouds, but his thoughts were necessarily so fully occupied with the unfamiliar task of managing the balloon that he had little time to give to scientific observations. He saw nothing of the earth for an hour, and, after traveling one hundred and twenty miles, he landed safely near the Serge monastery, not far from Moscow. In recognition of the pluck exhibited in this ascent, the Academy of Aerostation of France has presented a medal to Prof. Mendeleieff.

Posin, in the only full-length English language biography of Mendelejeff, and taking the account from Mendelejeff's own words, has presented the more charitable version, that the solo ascent was a deliberate action. In any event, Mendelejeff's initiative and self-reliance in handling the descent of the balloon into a clearing suitable for landing must be admired.

For our final selection we have chosen an account of a measurement carried out in China during the eclipse of September 22, 1968. In this case the use of airborne equipment, a development of the past century, was influenced and acted on by society in a manner perhaps not too dissimilar from that of our first selection. It would appear that while our control of the physical environment has progressed greatly over the past two millennia, there is still work to be done in controlling the impact of society on the individual.

> Successive trial-flights began after the airborne high-altitude observation team arrived at the airport in mid-August, 1968. When the plane went above 8,000 meters, some of them kept vomiting, some had acute headaches, some suffered stomach discomforts, and some felt their limbs go numb. When the plane reached an altitude of 10,000 meters, some of them had to lie down. Acute high-altitude sickness was a stern test for all members of the team and caused a fierce ideological struggle in their minds. Whether to face up to the difficulties and advance with courage or to beat a retreat was the question. . . .
>
> At this juncture, Peoples Liberation Army comrades led the members of the team in studying Chairman Mao's "three constantly read articles" ("Serve the People," "In Memory of Norman Bethune," and "The Foolish Old Man Who Removed the Mountains"). At a meeting to exchange experience in the creative study and application of Chairman Mao's works, aviation doctor Cheng said: "High-altitude sickness is also a paper tiger. You can defeat it if you dare to fight it and are good at fighting it. We must learn from Comrade Chang Szu-teh to fight and die for Chairman Mao." The deputy commander of a P.L.A. regiment encouraged the team members by telling them about

Continued on page 82

Celestial Events

by Thomas D. Nicholson

The Moon: A crescent in the evening sky in mid-June, the moon reaches first-quarter on the 18th, goes through apogee on the 21st, and becomes full on the 26th, when it will pass close to Jupiter. Entering the evening sky, the moon reaches last-quarter on July 3, goes through perigee on the 7th, and becomes new on the 10th. First-quarter in July is on the 18th, apogee on the 19th, and full moon on the 26th. Ending the month of July in the morning sky, the moon in August reaches last-quarter on the 2nd, perigee on the 3rd, and becomes a new moon on the 9th. By mid-August, the early crescent will again be seen in the evening sky. A partial lunar eclipse occurs on July 26.

The Planets: Look for Jupiter in the early evening, rising at sunset or earlier, visible until dawn in mid-June, but setting a few hours past midnight by mid-August. Mercury is also an evening star for most of the period and goes through a favorable evening elongation in July. Observers with a clear westerly horizon can see the planet low in the west–northwest shortly after sunset for about a week before and after July 10. The crescent moon should help on July 12. Mercury will be just to the right of the crescent in evening twilight.

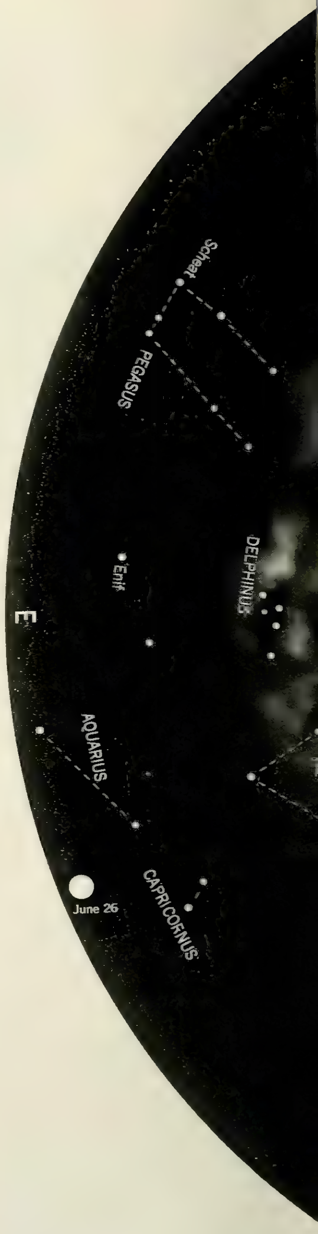
Mars is too near the sun to be visible this summer, but Saturn and Venus, having passed from the evening to the morning sky, will be getting prominent as morning stars by early July. Saturn rises first, among the stars of Taurus; Venus later, but far more brilliant. The crescent moon will pass near both planets in the morning sky of July 8 and again on August 4 and 5.

The Sun and Stars: A total eclipse of the sun occurs on July 10 (*pages 44-45*). In early evening, late spring stars are low in the west, summer stars high above, and autumn stars rising in the east. Winter stars are rising in the east by dawn.

Meteors: The Delta Aquarid meteor shower reaches maximum on July 28, but there will be a bright gibbous moon in the sky after midnight. When the Perseid meteor shower reaches maximum on August 11, however, the moon will be just past new. Expect Perseid meteors from the 7th through the 15th, with up to 50 per hour expected in the early morning hours of August 12, shortly after maximum. The skies after midnight, when observing is best, will be dark and moonless.

June 17: Venus, at inferior conjunction, enters the morning sky.
June 21: Summer begins in the Northern Hemisphere when the sun arrives at the summer solstice at 2:06 A.M., EST.
June 24: The moon occults Antares over Asia; Jupiter, at opposition from the sun, enters the evening sky.
July 5: Earth is at aphelion, 94,514,000 miles from the sun.
July 10: Total solar eclipse, visible in North America; Mercury is at greatest distance from the sun in the evening sky.
July 21: The moon passes close to Antares at 6:00 P.M., EST.
July 24: Venus is at greatest brilliancy in the morning sky.
July 26: Partial lunar eclipse, visible in North America (*page 49*).
July 29: Mercury passes south of Mars.
August 7: Mercury, at inferior conjunction, enters the morning sky.
August 11: Maximum of Perseid meteor shower.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:20 P.M. on June 15; 9:20 P.M. on June 30; 8:25 P.M. on July 15; and 7:20 P.M. on August 1; but it can be used for about an hour before and after those times.



Grassy meadows, caused by silt deposition and flooding, surround many beaver ponds. Farmers often cultivate these fertile fields.

Late last summer a pair of beavers built a dam on a brook next to Don Herron's cornfield in Leyden, Massachusetts. They gnawed down a stand of aspen trees, dragged them branch by branch back to the safety of their pond, ate the bark, and built their dam with the leftover sticks and logs. As the beavers added to the dam, the water rose, drowning pines and elms 400 feet upstream.

Then the pond began to inch into one corner of Herron's field. By night the beavers waddled up the furrows and carried back about a hundred stalks of corn. The stalks that they didn't eat went into their dam, making the water rise higher.

By building up the dam, lower left, beavers expand the pond to new food sources. The pond also kills pine trees by flooding.

Farmer Herron's sons tore a wide hole in the dam, but in a few nights the beavers had restored it, and the water rose above its original level.

In October, after he had lost a morning hauling his tractor and harvester out of the mud next to the beaver pond with a borrowed bulldozer, Herron called the western Massachusetts wildlife manager in Pittsfield for help. The state would be willing to take the beavers elsewhere, he was told, but they were probably better off in his brook. State parks were becoming overcrowded with transplanted beavers, and in other areas, property owners, especially summer residents complaining about noisy frogs at night, were making more requests to have

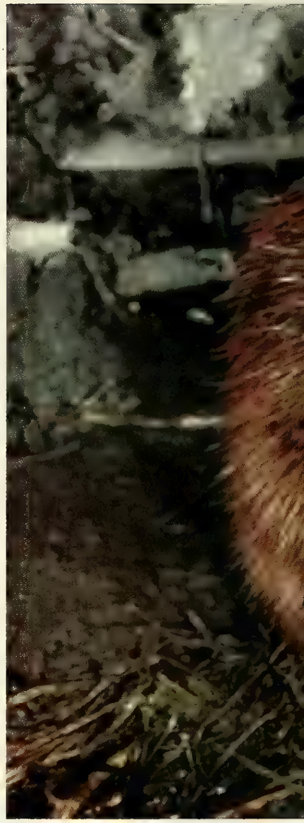
the animals livetrapped and removed than to have them placed on their streams. As a last resort, Herron, a landholder, could obtain a permit to destroy the animals by rifle, steel trap, or other means short of poisoning.

But you may justifiably ask, Which has the greater claim to the land—man or beaver? After having been nearly exterminated by trappers, beavers are finding their way back to meadows they had previously silted up, and they are now haunting property owners with doubts as to who is the squatter and who is the legitimate landholder.

The beavers' claim probably dates back to preglacial periods, when they moved upstream from lakes and rivers and created more stable, "artificial" bodies of water by damming up brooks. The first dams were probably mere accumulations of logs, sticks, and detritus. The basins of calmer water created by these natural dams and the edible deciduous trees along their edges would have attracted migrant beavers. Generations of beavers would have been waylaid by such basins before they began to put mud and sticks together to improve the already favorable conditions. Eventually, the beavers' damming skills were refined to the point that you can observe today: with mud and reinforcing sticks, they fill every place where water flows over the rim of the dam. By plugging spillway after spillway, the animals heap up a higher, wider, and more robust barrier, which spreads out laterally across the stream valley.

The stable ponds above dams offered more protection than fluctuating rivers and lakes. The uncontrollable water levels of rivers and lakes could flood the beavers from their nest hollows or drop below the underwater burrow entrances, exposing the entire colony of adults, yearlings, and kits to shoreline predators. The artificial ponds not only expanded the beavers' territory to new sources of deciduous trees but also set up a happy formula whereby one colony prepares the stream meadow for reforesting so that the next colony to take its place will have food.

As every farmer familiar with keeping the woods from invading



A beaver leaves its lodge by an underwater passage. The submerged entrances protect the inhabitants from predators.

Two-week-old kits nurse inside a beaver lodge. The young beavers normally leave the colony when they are two years old.

his fields knows, aspens are among the first trees to sprout in his grass. This member of the poplar family produces saplings that look and grow like weeds. The leaves of saplings, two or three times larger than those of the adult trees, catch a maximum amount of sunlight and spur on a growth of better than two feet a year. Aspens make up the vanguard of the advancing forest, leading the slower-growing maples, oaks, birches, and pines, which are less dependent on direct rays of the sun.

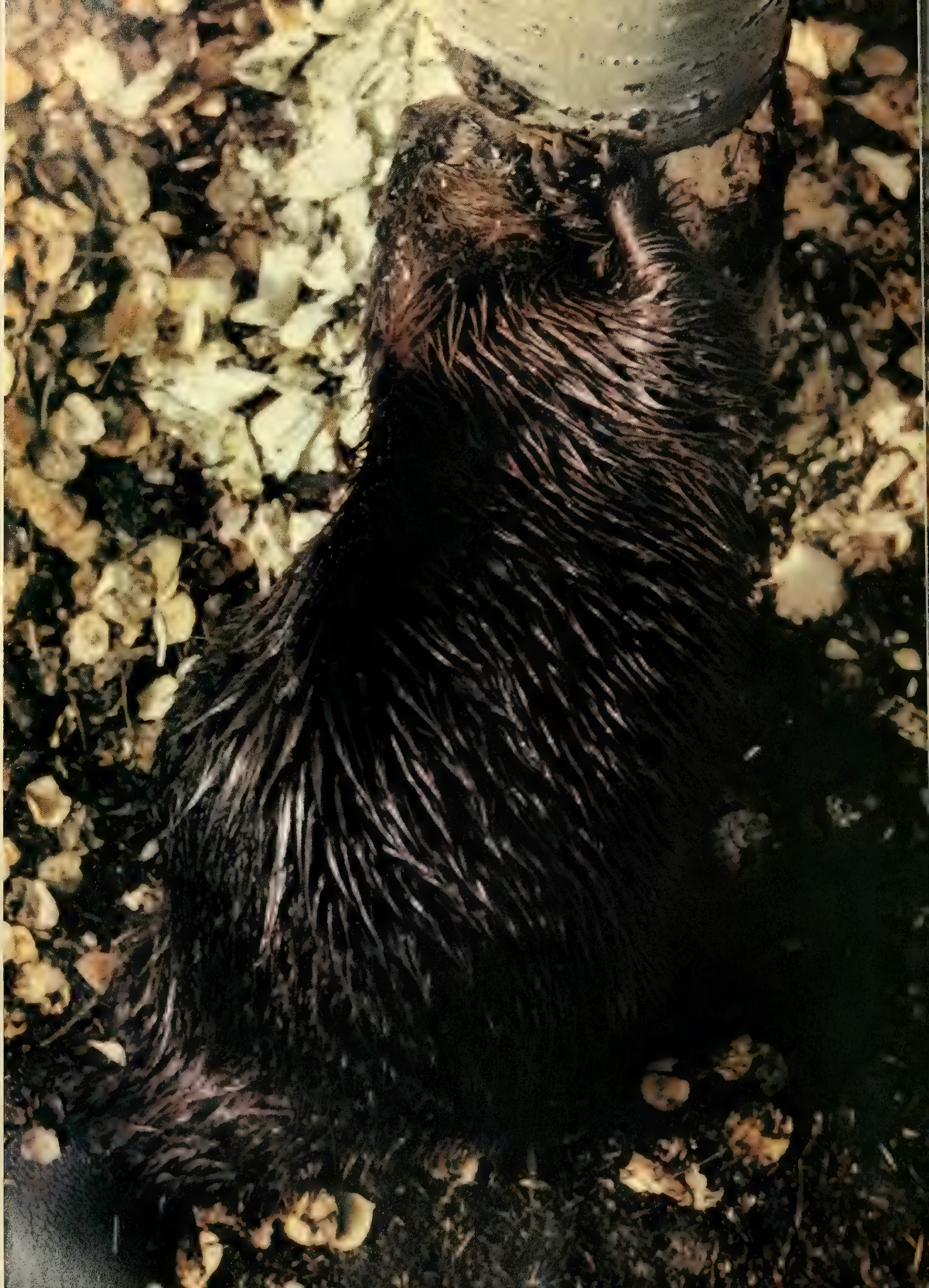
If the forest is allowed to spread over the entire field, the young aspens become thinned and choked out by the slower-advancing, but taller shade trees. Finally, conifers, bringing up the rear, block off the sun to all but a few of the tallest aspens. Eventually, the remaining aspens die off, and what was once open field becomes woods too dark for the survival of new aspen seedlings.

In this one-sided competition between aspens, the beavers' basic staple, and pines, the only type of tree they will never fell or eat, beavers interceded on the part of the aspen.

By flooding areas long enough to drown conifers, the beavers opened clearings where aspen could make its typical interim stand after the flood receded. The more land the beavers cleared, the more aspens and other edible trees they reaped, thereby enabling the colony to remain longer at a brook site.

In addition, the longer a dam was maintained, the more silt accumulated. Thus, over many years the beavers built up wide, gently sloping beaver meadows. During this fruitful symbiosis between animal and aspen trees, the beavers must have settled down to the "agrarian" lives they now lead. One colony comes into a meadow to reap the crop planted by previous tenants and at the same time to improve the land, thereby providing a slightly superior crop for future tenants.

Once the aspens and other edible trees at a beaver pond are exhausted, the territory is abandoned



and the dam rots and breaches. The water drains and the pond bed becomes a fertile beaver meadow where aspen seedlings soon sprout. After perhaps ten years, the saplings are large enough and abundant enough to attract a beaver migrating along the brook of the meadow. The beaver cuts the nearby trees, carries them back to the brook, and begins to erect a dam. The cycle starts anew.

This cycle accounts for the astoundingly provident choices that beavers make for their damsites. They almost always select a stretch of stream with enough aspens to tide an entire colony over at least one winter, and they also settle along streams that will neither dry up in August nor wash out their dams in March. Walk for a half mile upstream and downstream from a beaver colony and the chances are that you could not find a better damsite. Not only will the beavers' choice meet the above conditions, but the dam will also back up at least an acre-sized pond that is deep enough so that the animals will not be ice-locked in their lodge in February. To make all these extraordinary calculations a migrant beaver needs neither intelligence nor instinct, but only a keen nose and an appetite for the aspens growing in the meadow created by the previous occupants.

All this brings us only a little closer to understanding Don Herron's beaver problem. In the early eighteenth century, the beaver population had probably reached its ceiling. The meadows must have been heavily worked, and the pines pressing along the edges were inched back, allowing a few more aspens to take root. By the first decades of the nineteenth century, when beaver hats reached their greatest popularity, the beaver population in all but the most remote areas of North America had been drastically reduced. The open ponds were a dead giveaway to even the most inept woodsman in search of beaver pelts. He needed only to make a small breach in the dam and wait with gun or trap for the repairer to arrive.

After felling this aspen near the edge of a pond, beavers will chew off its branches and drag them to the lodge or dam.

Settlers quickly claimed the beaver meadows as the choicest pieces of land and took up farming where the exterminated colonies had left off. This was the case of Beaver Meadow in Leyden and no doubt of many other southern New England stream valleys similarly named by early inhabitants who still remembered the dams and ponds. In northern areas of New England and the Adirondacks where beaver meadows were never reached by farmers, pines crowded back to the edges of streams.

In about 1905, a number of beavers were transplanted from the west to the Adirondacks. Protected by new laws, these immigrants, along with the few beavers that had survived the slaughter, completely reversed the gloomy outlook for the species.

By 1921 the beaver population in the Adirondacks had expanded to the point that fishermen were complaining that the animals were opening the forest canopy, which let the sun heat up streams and supposedly made life miserable for brook trout. Timber concerns accused beavers of drowning off hundreds of acres of pines that had grown on beaver meadows. Both complainants ignored some of the benefits. The beavers were restoring water tables and controlling floods by holding back millions of gallons of spring and fall rains that otherwise would flush out to sea.

The extraordinarily rapid renaissance of beavers was due primarily to the heritage they had left behind in beaver meadows. Although contemporary beavers, like their nondamming ancestors, can and often do carry on muskratlike existences along lake and river banks, they gain much better access to food trees by flooding and controlling their territories along brooks. Beavers of the Adirondacks, as well as those now found all across northern Vermont, New Hampshire, and Maine, had to clear their meadows of undesirable evergreens much as their early damming ancestors had to inch back the primeval forest. Contemporary beavers, however, are enormously advantaged by the perfectly sloping and broadened meadows beneath the evergreen forests. With only one deftly placed dam they can drown off and push back the same two or three acres of trees that had taken their forefathers thousands of dams. This dramatic assault on conifers must have been what so alarmed the Adirondack timbermen.

In the more settled parts of the east—especially central and southern New York State, Pennsylvania, southern Vermont and New Hampshire, and most of western Massachusetts—the expansion of the beaver population was additionally favored by the great number of deciduous trees that grew back in beaver meadows as farmers abandoned the land for cities. The European settler had profited from earlier occupation of meadows by beavers. Now beavers are profiting from the 200-year occupation by dairy farmers, fruit growers, and loggers, who kept conifers out of both the meadows and the uplands. As a result, the aspen has become one of the most common trees in the east.

Driving through the eastern countryside, today you can see many flooded areas with dead trees standing trunk-deep in water. These attest to the rapid proliferation of beavers over the last half-century as they reclaim their ancient meadows. In western Massachusetts, which is fairly typical, beavers were released in Lenox by the local Audubon Society during the early 1930s. By 1945 the population had expanded to the point that a trapping season was opened. Now, state game manager Winston Saville, who for the last 25 years has been watching out for new homes for livetrapped animals, says, "If a stream has not al-

ready been discovered by beavers, there's probably something wrong with it." Most beaver ponds are gradually being restored to how they must have looked 300 years ago. The tall, ghostly hemlocks, elms, and other drowned trees will eventually be blown down, making the pond more lakelike.

The great success of this crash program can also be explained by the unusual breeding and colony habits of these rodents. A pair of beavers produce a litter of four to six kits only once a year. But due to the great size of the animals and the two-year-long maturation period during which the young remain with the parents, a colony may soon severely strain its food supply.

A colony in Michigan, which zoologist G. W. Bradt livetrapped each year from 1929 to 1933, was started in 1928 with a pair of adults weighing probably between 40 and 50 pounds each. In May of 1929 a litter of four kits was born, bringing the colony to six. In May, 1930, six more kits were born, which brought the colony to its apparent ceiling of twelve members. Before the birth of each successive litter, the parents drove away all the two-year-olds, thus ridding the colony of these voracious adolescents, which then had the entire summer in which to roam about streams and lakes and establish their own colonies. Bradt's colony, which produced litters of six, four, and six kits during subsequent years, remained at an even twelve members until 1933 when the food trees finally gave out and the colony migrated.

Although most colonies—especially in states where trapping is permitted—usually average fewer than six members, the parents nevertheless drive away the adolescents as well as intruding noncolony members, thereby keeping their flooded land exclusively to themselves. In doing this, they are acting out complex and subtly interlocking behavioral patterns, influenced by the maturational and hormonal changes constantly going on in developing kits, yearlings, and adults. One result of these little-understood processes is an extremely well-managed meadow in which the trees are rationed out to last at least through the two-year maturation period of the first generation.

By the colony's second year, when food demand has reached its peak, the ponds usually begin to produce enough algae, duckweed, and water lilies to take some of the strain off the trees, which will be needed in the fall for winter caches.

Often by the third year, when the food trees within reach of the main pond have become exhausted, the animals begin to build canals and secondary dams along tributaries and up and down stream from the main pond. In this way they can tap more remote food sources, which last for several more years, until the supply lines back to the main pond and lodge become overstretched and the area must be abandoned.

The involved and oddly reversible relationship between beaver and man is being revealed by present-day beavers. As they work back into their old niches they remind man of what he had forgotten. One colony in Leyden, which I have been observing since 1968, settled into a meadow that, over the last hundred years, had become so overgrown with elms and aspens that I did not realize it had once been planted with apple trees. I found apple seeds in the beaver feces, and on following several freshly trampled runways inland from the pond for about one hundred feet, I was led to several ancient trees still bearing fruit. For the next four years the animals embraced this human heritage, beating a trail back to the trees where every night they fed on the fallen apples.

Another colony plugged the culvert pipe under West Leyden Road with mud and sticks. As the water backed up the stream valley and then began to spill across the asphalt, it became clear that the beavers had turned the road into a dam. Before then no one had realized how much labor the beavers had saved earlier road builders—not only by filling up and leveling out the valley but also by leaving behind long mounds of earth from an early dam, which possibly served as a blueprint for the roadbed.

Such mounds, remaining from the tons of sticks, logs, and mud that beavers pile on their dams, are frequently found on the downstream end of beaver meadows. They extend toward each other from both banks of the stream valley, perfectly level and with a curious symmetry that makes them appear like enigmatic earthworks left by some aboriginal human inhabitants. They are great labor savers for the next beavers that inherit the meadow. With only a little breachwork from one mound to the other, the animals can bridge the stream, re-creating the same pond that had been tried and proved successful by previous inhabitants. When the beavers of West Leyden Road returned, they found these mounds of their ancestors considerably improved by man's roadmaking activities.

A similar example of such beaver–man archeology can be found in Guilford, Vermont, where a colony had constructed its dam against a stone wall probably laid about the time of the Revolution. But when the animals recently abandoned the pond and the water level dropped, exposing the wall's foundations, it became apparent that an early Yankee had built his wall atop the mounds left from an earlier beaver dam.

Even if Don Herron did somehow get rid of the colony now occupying his land, the problem would soon return. Other beavers migrating along the brook would be attracted to the site. Backed by the ancient work of their ancestors, they would rebuild the dam and, as the waters slowly rose, gently reassert their valid claim.

Did 10-foot beavers cut down these trees? Or beaver-toothed monkeys? Actually, ordinary beavers standing on deep snow did.

What's Biting You?

Millions of Americans will flock to camps, parks, and wilderness areas this summer for their version of personal communion with Nature. All too often, however, Nature communicates back in unpleasant fashion, particularly when those millions of Americans become targets for billions of bugs. To better acquaint people with their tormentors, we have prepared a rogue's gallery of some of the assorted biting insects and arachnids (such as spiders and ticks) most frequently encountered out of doors. The photographs were prepared with the aid of a scanning electron microscope. The great resolution, depth of field, and startling clarity of scanning electron micrographs reveal a wealth of detail and beauty not appreciated by any other means.

The basic biology of biting insects and arachnids has attracted the attention not only of entomologists but of physicians, veterinarians, and medical researchers, as well. This is due to the many health and disease problems associated with these arthropods.

At their very least, insects are a source of discomfort and irritation. Some of the insects, spiders, and ticks pictured on these pages—the mosquito, flea, gnat, crab louse, and tick—bite humans to obtain food. The pain or itching that often results from their bites is caused by the injection of saliva, which contains substances that aid the feeding process, rather than by the puncture of the skin itself. These substances can include anticoagulants (substances that retard blood clotting). The body reacts to these substances with both immediate and delayed allergic responses, resulting in pain, itching, and localized swelling and edema.

The black widow spider, the western spotted corsair, and the honeybee bite or sting humans only in self-defense. In these cases, toxic venoms produce the resultant pain. The toxicities of the venoms vary. Black widow spider bites are rather dangerous, with a human fatality rate of 1 to 5 percent. Honeybee stings, on the other hand, are far less dangerous, except to individuals who are especially allergic to bee stings. For these people, even a single sting can sometimes prove fatal unless appropriate therapy is started promptly. Most people who are allergic to bee stings show allergic response, not to the venom itself, but to other substances introduced along with the venom.

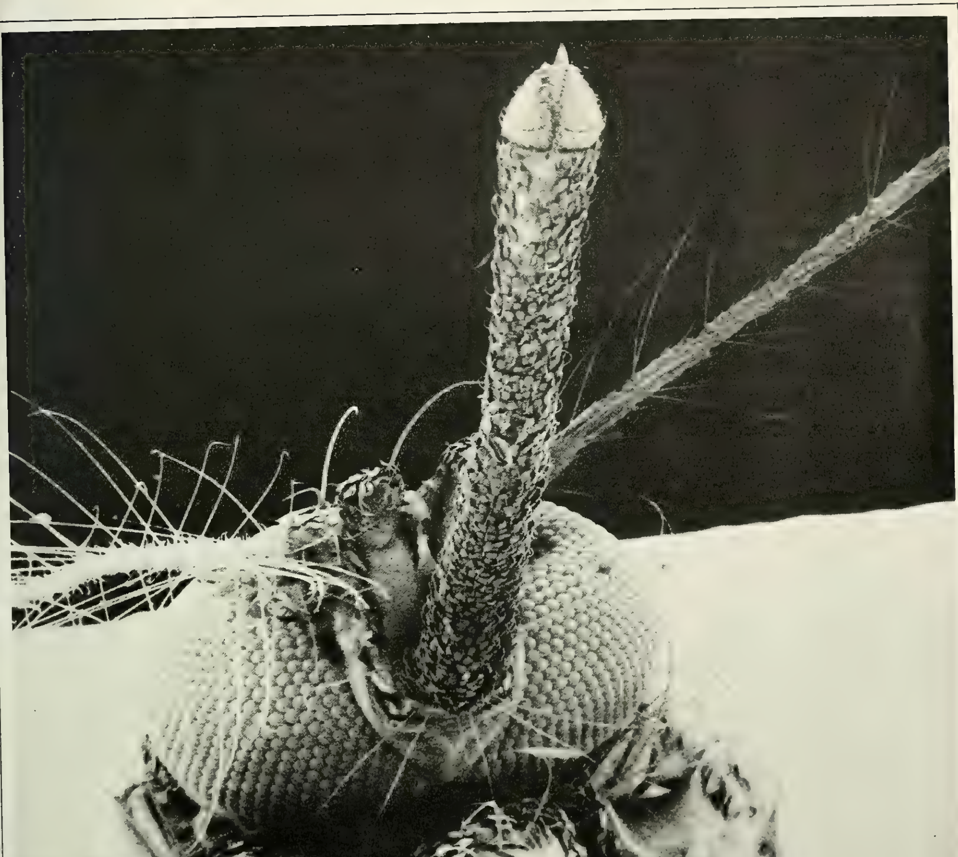
Far more serious as a general health problem than mere irritation or even direct toxic effects of insect or spider bites is the role played by biting insects in the transmission of disease. The list of insect-borne diseases is a very long one and includes such major health problems as malaria, yellow fever, typhus, encephalitis, and plague. The pathogens carried by insects include viruses (encephalitis and yellow fever), rickettsiae (typhus), bacteria (plague), protozoans (malaria), and roundworms (filariasis). Fleas transmit plague from small mammals, such as rats and other rodents, to man. The species of mosquito pictured on page 75 can transmit yellow fever, dengue (a viral-caused disease), and equine encephalitis (a viral disease of horses, mules, and, occasionally, humans). Certain species of ticks (but apparently not the one pictured on page 81) transmit Rocky Mountain spotted fever.

Biting insects frequently exhibit complex life histories. Larval forms may show very different habitat and food preferences from those of the adults. Mosquito eggs are laid in water and hatch into aquatic larvae, most of which feed on microscopic plants and animals in the water. Following pupation, the adult emerges to breed and complete the life cycle. Only female mosquitoes feed on blood; males feed on plant juices and nectar. In many species, development of the eggs can occur only after the female has taken a blood meal.

The larvae of biting gnats, like those of the mosquito, are not themselves blood feeders. The valley black gnat spends its larval life beneath the soil. In California, adults emerge as the soil dries and cracks during the first hot days in the spring. Again, only the female is a blood feeder. The larvae of fleas generally live away from the hosts they will parasitize as adults, preferring the nests of hosts or other sites where there are quantities of detritus favored as food. Only the adult fleas adopt a blood-sucking mode of existence.

Humans play host to three varieties of lice: the crab louse, *Phthirus pubis;* the head louse, *Pediculus humanus capitis;* and the cootie, or body louse, *P. humanus humanus.* These are all of the insect order Anoplura, or sucking lice: a group of wingless ectoparasites of mammals, with flattened bodies and legs adapted for clinging to hairs. The three lice tend to inhabit different regions of the body: The first is found predominantly in the pubic region

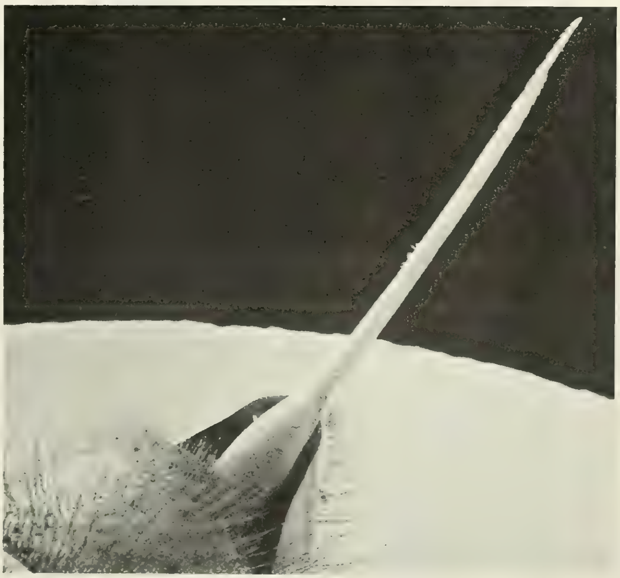
by Peter B. Armstrong, David W. Deamer, and John J. Mais



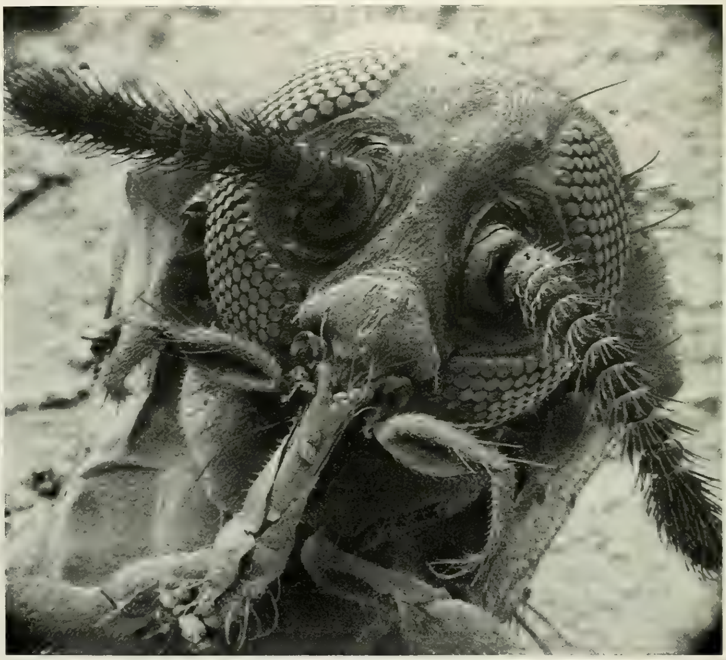
The triangular tip protruding from the very end of this mosquito's proboscis is the part that actually penetrates a mammal's skin to reach the blood. The sheaths on either side are drawn back to fully expose it. At each side of the head are the hemispheric eyes, each composed of several hundred individual facets. Here the mosquito's head is 183 times life-size.

The long, pointed proboscis, which administers a painful sting, is evident in this view from beneath a western spotted corsair. Farther back are the hemispheric eyes.

The head, above, and the stinger, below, at the other end of a honeybee. The stinger is left in whatever the bee has stung; tiny barbs at the tip make it difficult to remove.



The heavy, hooked jaw parts of a female black widow spider dominate this head-on view. One to 5 percent of humans bitten will die.



The head of a biting gnat, an insect that can cause extreme discomfort to mammals through its sheer numbers. The species shown here is found in the Central Valley of California.

A human crab louse is seen here from underneath. The thick legs and large claws are used to grasp hair shafts on the host.

(only rarely in the hair of the armpits or head); the second in the hair of the head; and the third in the clothing. Eggs of the crab louse and head louse are attached firmly to hair shafts, while those of the body louse are laid in seams in clothing. Infections of crab lice and head lice are difficult to control by simple soap-and-water washing because the eggs are very difficult to dislodge and usually survive. Highly effective lousicides are now available, however. Lice are transferred by direct contact or contact with contaminated clothing, furniture, and so on.

In terms of a major health hazard, the body louse presents the most severe problem because it is the principal agent for transfer of epidemic typhus. The disease can be especially severe in wartime and often has a high mortality rate (Russia lost two to three million persons during World War I to typhus). The pathogen responsible for the disease, *Rickettsia prowazeki*, is a member of a peculiar microbial group, the Rickettsiae. These seem to be somewhat intermediate in characteristics between viruses and bacteria. The typhus organism multiplies within the intestinal cells of the louse and is transferred to persons through

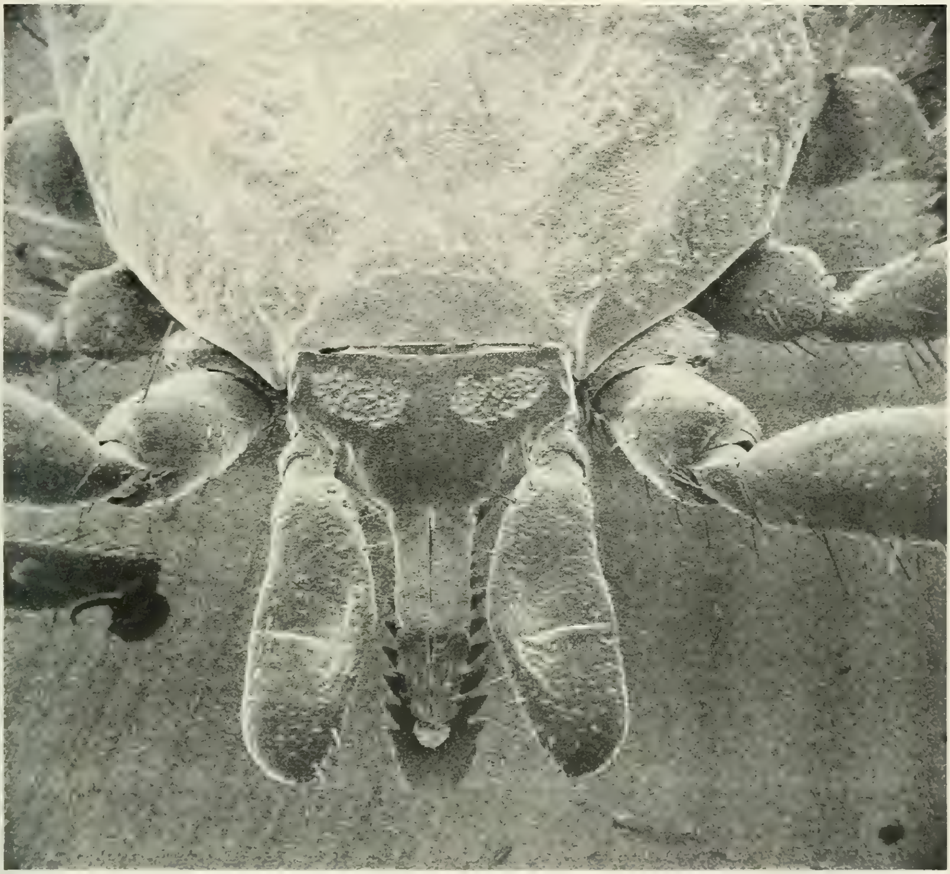
From the side, the cat flea resembles a medieval Japanese knight in full armor. The toothed plates and backward-directed spines allow movement through the hairs of a cat or dog only in the forward direction and thus increase the difficulty of removal by scratching.

scratches in the skin when an infected louse is crushed.

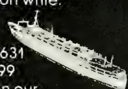
The evolutionary adaptations to a life of biting, stinging, and blood sucking are often very interesting. These include anatomical adaptations, ranging from the development of massive biting or stinging mouthparts, such as those of the black widow spider, the western spotted corsair, and the mosquito; the presence of backward-directed serrae, or barbs, on the mouthparts as shown by the tick; and the occurrence of the long, sharp-barbed stinging dart of the bee, really a modified ovipositor.

In addition to anatomical adaptations, physiological and biochemical adaptations for biting and stinging are also important. The venom of the black widow spider or the western spotted corsair is intended to kill or paralyze its prey (usually an insect) and is injected into the wound made by the biting mouthparts. Some mosquitoes inject anticoagulants prior to the start of blood sucking, probably to lessen difficulties resulting from clotting.

These, then, are some of the biting insects. Scanning electron micrographs reveal their beauty and unexpected complexity. Think about it, just before you slap that next mosquito or gnat to death.



When biting, the tick thrusts the serrated biting organ at center through the skin into deeper-lying tissues. It is these serrae that make dislodgment so difficult.



Eclipses:

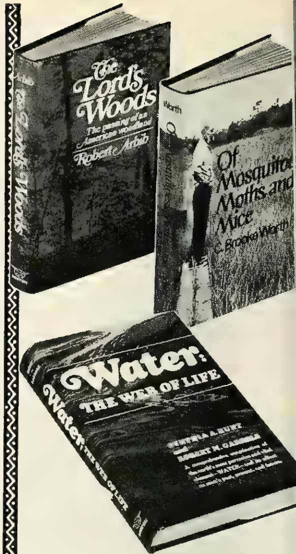
Continued from page 51

the heroic deeds of Huang Chi-kuang, who threw himself on an enemy machine gun to enable his comrades-in-arms to make a charge and about the staunchness of the Red Army, which climbed snow-covered mountains and crossed marshy grasslands during the Long March.

Chao Hsiu-ching, the only revolutionary young woman in the airborne observation team, lost quite a bit of weight after a series of high-altitude flights. Once she felt sick and worried about whether she should fly the next day. She lay awake that night thinking of Chang Szu-teh who served the people "wholly" and "entirely," of the Foolish Old Man's determination to surmount every difficulty, and of Comrade Bethune's communist spirit of absolute selflessness. She all the more thought of the hopes Chairman Mao placed on China's younger generation and his deep solicitude for it. She made this pledge: "I must fulfill the task!"

The next day, Chao determinedly boarded the plane. Unwell and subject to high-altitude sickness, she suffered from headache and had a pain in her side. But she always bore in mind Chairman Mao's great teaching: "Be resolute, fear no sacrifice and surmount every difficulty to win victory." With unswerving tenacity, she overcame one difficulty after another and fulfilled her task splendidly. When her comrades praised her, she declared: "All the credit should go to Chairman Mao. In winning every victory, we depend on Mao Tse-tung's thought!"

Inspired by Mao Tse-tung's thought, the members of the airborne observation team displayed revolutionary heroism and flew at an altitude of 11,000 meters in a nonhermetically sealed cabin, thus breaking the world record of 9,000 meters set by some foreign countries in airborne observation from a nonhermetically sealed cabin. They obtained the world's most complete data on a solar eclipse observed at high altitude. ■



Continued from page 23

toilet, and a television set to sustain flagging interest in Big Sky Country.

That was idyllic for the motorized outdoorsman until he found his camper blocked by natural barriers beyond the asphalt frontier. Since America moves on wheels, further conquest came by motorcycle, snowmobile, jeep, trail bike, all-terrain vehicle, dune and swamp buggy, and even Hovercraft.

More than 1.5 million snowmobiles, with a value approaching $2 billion, are estimated to now be in use. Production of all-terrain vehicles, potentially the most pernicious of all motorized recreational vehicles (MRVs) went from a reported 15,000 in 1969 to about 40,000 in 1970. Output is expected to reach 225,000 by 1975. These conveyances, yoked to recreation industry profit and real estate speculation, have enabled man at rest to inflict a brutal impact on the environment.

Mobility, money, technology, and leisure are dancing together in a seemingly infinite spiral: technology provides leisure; leisure generates money by permitting part-time, short-term second jobs; money buys mobility.

Real estate speculators begin developing areas opened by the new mobility—high rises by the sea, second homes inland. Roads are built to serve the developments and increased accessibility brings people with time and money to spend on travel. Fast-food franchises spring up to feed them, whirling off patrons in a fog of plastic exhaust. Exit idyllicism. Enter vacationers madder than hell at what's happening to the place and wondering who is to blame.

Pointing a finger at the culprits who actually began the chain of environmental offenses is simply not acceptable to the offenders. Not many persons of moderate income, who have worked for their time off, would be willing to confess wrongdoing in exercising the same privileges in leisure that wealthy cosmopolites have enjoyed for centuries: to go where they want, when they want, supplied with basic amenities. Besides, this is no venal pollution by industry. It is we who are pursuing something in nature, and the pursuit is not one of personal gain.

Efforts to initiate meaningful research into the problems involved are handicapped by man's ignorance of his ignorance. In 1962 sociologist William A. Faunce conducted a survey among auto assembly-line workers to determine how they would use the free time a four-day work week would bring. About 20 percent said they would return to school. Steele and Poor's study of employees with the leisure already in hand, however, disclosed that less than 6 percent sought out education, and their number was heavily weighted with managerial personnel and individuals who identified themselves as students working to finance their studies. Only 4.8 percent of Faunce's respondents reported that they would engage in water-sport recreation, while Steele and Poor found 48.6 percent actually doing so.

Research into what motivates the "getaway person" is necessary if we are going to prevent the kind of unplanned exploitation of the environment that characterized the coming of industrialization. Rational management of the country's recreational resources must evolve from detailed studies based upon the social, as well as the biological, sciences before technology inundates what esthetic values and natural areas are left. Curiously, this approach is not meeting favor with many old-line conservationists, sure in their faith that people go to nature for nature. Their wilderness ethos simply has not permitted them to seriously consider that a man looking at a sublime mountain vista from the door of his multigadgeted camper may be where he is primarily for the sake of the camper and its gadgetry, not for the vista—and certainly not for sublimity.

The suggestion that today's mobs of motorized outdoorsmen are drawn to the wilderness primarily to use their machinery, not to touch nature, has been considered a near obscenity in polite ecological dialogue. But recognition of this possibility may be an important key to dealing with all forms of environmental degradation caused by mil-

lions of tourists with three-day weekends to fill.

Government research and planning into the implications of increasing leisure are scarce, however. It is only within the National Park Service that a specialized research team is studying the problems in terms of changing work patterns and leisure trends. The findings of the group promise to become important elements in the future management of the country's recreational resources.

There is some supposition among federal officials that, if the problem is one of ignorance, education is the obvious cure—education to bring people into meaningful contact with coastal and inland wildernesses and to teach them wildlife appreciation. To instill a love of nature in the young, the National Park Service hopes to eventually bring its interpretive programs to every school within fifty miles of a national park. ("If we called them 'educational programs,'" remarked one Park Service interpretive specialist, "some Congressman on appropriations would order them out of Interior and over to HEW. HEW wouldn't have the faintest idea of what to do with an educational program on the California condor and that would be the end of that.") After beginning in 1968, it reached 27,000 youngsters in 1969, and more than 58,000 in 1970. The Bureau of Sport Fisheries and Wildlife has a similar, but less developed, effort under way.

These are worthy steps, but small ones when dealing with a population of more than 200 million. And the worthiness of the program's aims are not above dispute. Although the interpretive specialists perceive their goal as education, not everyone in the National Park Service sees it in quite the same way. There is a good deal of talk, for instance, about interpretive programs "projecting the image of the service."

Scholastic endeavor, moreover, can be as ecologically devastating as intentional destruction when it is improperly conducted. California's Pacific tidal pools, Vermont's Green Mountains, and other diverse resources have been roughly handled by well-intentioned teachers and their swarming classes whose only expertise was in curiosity.

Some conservationists accept th notion that we are catering the re mains of our natural estate t people who clutch at them knowingly or not, as merely obtain able substitutes for other, unarticu lated desires. These people may want something other than caves o ice, stillness, or simply, beache bereft of bikinis. This something else may be opulent surrounding and differential treatment at resor hotels. An opportunity for machine tinkering, new gadgetry, speed, and a sense of power may provide th necessary outlets.

In recognition of what is becom ing increasingly apparent, planners are beginning to speak of estab lishing technologically nourished "high-intensity" recreation centers at the rims of metropolitan areas Nature would be cultivated as an enhancing fabric around the visitor's genuine interests. There would be water sports, shooting, mechanized camping, and special facilities for MRVs. Hotels and chalets with impressive views, movies, theaters, restaurants, arcades of games and exhibits, children's activities, and other diversions would complete the pleasure dome.

As might be expected when a ripe potential for profit exists, private enterprise is stepping in to meet an obvious need with commercial schemes designed to cater to the public taste. Walt Disney Productions, a leader in the field, possibly showed the way with the pioneering Disneyland in California. With that tremendous success behind them, their new fantasy world in Orlando, Florida, is now in operation and on its way to becoming one of the nation's leading vacation spots. Astroworld in Houston, Texas, is performing a similar function for that area of the country. Perhaps even more threatening and revealing as to the future, Disney is planning to build a ski resort and vacation complex in the Mineral King area of Sequoia National Forest, California.

Other proposals for high-intensity recreational facilities are integral to futuristic plans being spawned by some imaginative thinkers. The ideas include turning cities into great leisure-hour fun centers, low-profile mass transit throughout critical wilderness regions to replace motor vehicles, er-

satz nature enjoyment in special motion picture theaters with sound, smell, and 360-degree screens, and even behavioral engineering to make people fit available leisure resources rather than vice versa.

A proposition that government enter into partnerships with private enterprise to plan and construct the types of recreation centers now springing up unchecked all over the country is another concept that might profitably be considered. Such pleasure domes would offer specific, varied uses for the leisure of a great many people, siphoning off pressure from vital natural resources. They would require limited amounts of open land and proximity to bodies of water, but not the best of national wilderness resources. More important, site selection and composition would be under government control, but private corporations would supply the capital, obviating the necessity of raising the needed money through taxes.

Whatever actions are finally taken, the time factor is growing more critical as the four-day work week and its ramifications roll inexorably toward us. The problems are coming into focus, and enlightened conservationists are seeing the danger in some of the more futuristic schemes that, to the present, have had no research planning. "Are we going to save the wilderness from three-day weekenders by turning it into a vast, organized playground?" is one of the pertinent questions now being asked.

Supreme Court Justice William O. Douglas believes that "alleyways and playgrounds pit man against man," whereas woods, lakes, and mountains can soften him and make him self-reliant. Some leisure-prone Americans have long treated the outdoors as alleyways and playgrounds. For them, nature is incidental to the picnic table, the motorized trail bike, the radio, and beach buggy.

Environmental specialists may wring their hands, but something more is needed. If the dream of leisure is not defined and if the growing numbers of people with free time are not given an opportunity to find their own pleasure domes, then wilderness and wildlife, as well as those who love both, will be the losers. ■

The Naked Cell

Continued from page 26

plasts can be made to fuse. The trick appears to be the use, not of inactivated viruses, but simply of an appropriate concentration of sodium nitrate. The sodium nitrate appears to have the same effect upon plant cells that inactivated viruses have on animal cells. Fusion is frequently seen, and fusion products can form cell walls. In a few cases they go on to divide. As far as I know, no product of protoplast fusion has yet produced any differentiated organs or organism, but probably the only block to such a realization is further experimentation and some tricks of technology.

Plant protoplasts have a remarkable ability to envelop and, ultimately, to ingest rather large particles, such as tobacco mosaic virus particles and even little balls of synthetic latex several microns in diameter. When the foreign particle comes up to the membrane of the protoplast, the membrane forms a sheath around it, and eventually folds together into a vesicle, or blister, containing the particle. The vesicle migrates to the interior of the cell and then dissolves, releasing the particle inside the protoplast. This immediately suggests some new possibilities for transforming cells.

DNA (deoxyribonucleic acid) is the molecular basis of heredity. RNA (ribonucleic acid), a smaller molecule, can act as a messenger, carrying information from DNA to the cell. In numerous experiments, investigators have introduced foreign DNA into microbial cells, usually as a virus-transmitted genome, but even as a DNA solution. In some instances, when the host cell with its foreign DNA replicates itself and divides, it also replicates the foreign DNA. This means that new biochemical potentialities have been permanently introduced into the host cell. Since naked protoplasts can ingest viruses, they should be able to ingest functional DNA and RNA and thus become permanently transformed.

Experiments conducted in several laboratories indicate that foreign DNA can be incorporated into host plant cells, leading to permanent transformation of the host. In Germany, Dieter Hess has injected DNA from genetically pink or red petunias into albino petunias. In a significant number of cases, the albino petunias became pigment producing. The inference is that the genes for pigment-making enzymes have been successfully transferred from cell to cell. While there are many aspects of this experiment that leave geneticists unconvinced, it seems to me that the indications are hopeful.

In experiments in our Yale University laboratories we have introduced foreign RNA into tobacco pith cells (these cells have been most successfully cultivated into complete plants). This foreign RNA alters the enzymatic composition of the tobacco plant cells. Although we have not been able to demonstrate that the introduced RNA is replicated when the cells replicate themselves, the experiment seems to us important in demonstrating the possibilities for further experimentation.

Putting all the pieces of evidence together, it seems possible that in the near future we will be able to isolate protoplasts from almost any plant and feed foreign DNA or RNA into these protoplasts. In some cases the DNA or RNA will be incorporated into the host cell, which would then form an altered mass of plant cells and ultimately an altered intact plant. Through the use of this technique we could acquire an entirely new approach to the production of new plant genotypes.

With all the difficulties ahead for the experimenter in this new field of parasexual genetics, you might ask, "Why go to all the trouble? Why not simply continue with conventional genetics and produce new types of plants by the old tried and true methods of pollination, fertilization, and harvesting of seeds?" There are many answers to this question, but the most important is that certain sexual combinations are barred to the experimenter simply because of the incompatibility between the pollen tube of one plant and the stigma of another. In general, you cannot achieve sexual fusion of the sperm and egg through pollination unless the plants are very closely related. This means

that some desired crosses could not be achieved through conventional techniques, but the crosses might be possible if greatly dissimilar cells fused in the test tube as naked protoplasts.

Perhaps we could be permitted a few wild dreams at this point. For example, the tomato and the potato are in the same family, Solanaceae. This suggests that their cells might be fused in vitro. If they regenerated a plant, what would it look like? Would it produce both tomato fruits and potato tubers? Or potato tubers with the ascorbic acid content of a tomato? Or would it be a useless mélange of the two genotypes, producing none of the benefits? It is, of course, impossible to say until the experiment is done, but the possibilities are there.

Let us consider another, even more exciting possibility. On a worldwide basis, the greatest limitation to plant growth is the low level of nitrogen in the soil. Nearly all the nitrogen in the biosphere has come from biological nitrogen fixation, that is, the conversion of free atmospheric nitrogen into a compound suitable as plant food. This is carried out either by free-living organisms in the soil, which use decomposed organic matter as energy sources for the nitrogen fixation and growth, or by the symbiotic nitrogen fixers, which live in the nodules of leguminous plants and certain other species. The occurrence of nitrogen fixation by nodules is so scattered throughout the plant kingdom as to make little phylogenetic sense. If we could take plants that do not now fix nitrogen and fuse their protoplasts with plants that do, then perhaps the nitrogen-fixing nodules could be incorporated into the plants that do not now possess the habit.

What a boon it would be if we could induce corn, wheat, or rice to become nitrogen fixing in this way! Not only would we save the expense of tons and tons of nitrogenous fertilizer, but we would also avoid the pollution caused by fertilizer salts. Best of all, we might greatly increase production of the world's most important class of food plants. At the moment this is a dream, but it might just come true.

Arthur W. Galston teaches biology at Yale University.

The Strange Case of Paul Kammerer

THE CASE OF THE MIDWIFE TOAD, by Arthur Koestler. *Random House, $5.95; 187 pp., illus.*

Arthur Koestler has resurrected the case of the midwife toad, a scientific *cause célèbre* in the early 1920s, but largely unknown to biologists who succeeded the generation of Evelyn Hutchinson, Paul Weiss, and J. H. Quastel, all of whom played significant roles in the story, without getting caught in its tragedy. To put the matter as briefly as possible, during the first two decades of this century a gifted member of the staff of the *Biologische Versuchsanstalt* in Vienna, named Paul Kammerer, performed three series of experiments purporting to demonstrate the inheritance of acquired characteristics.

The most extensive involved the breeding of two different species of salamanders, each in the environment appropriate to the other. After two or three generations, the offspring developed coloration appropriate to the environment in which they were raised, but quite different from that of their ancestors. In the second series, the siphons of sea squirts were caused to elongate by repeated amputation. The offspring produced similarly elongated siphons, presumably as a result of an induced genetic change. Finally, eggs of the land-living midwife toad were incubated in water (a very difficult trick: Kammerer succeeded with only 3.5 percent of his eggs, and others failed entirely). The

Paul Kammerer in 1924, age 44.

adult males of the fifth generation raised in this way developed nuptial pads on the hands appropriate to aquatic life, but not to the land-living species of Amphibia from which they were descended.

These findings naturally aroused a good deal of skepticism in the biological establishment, but for reasons hard to understand at this distance, the debate rapidly focused on the forelimb of the one remaining specimen, only fairly well preserved in a glass jar in the Vienna Institute. After multiple inspections and much argument by many of the noted zoologists of the day, both in Vienna and London, the specimen was suddenly revealed as a possible

forgery by none other than G. K. Noble, then beginning his distinguished career at The American Museum of Natural History. Six months later, a few days after Noble's findings were published in *Nature,* and a few days before Kammerer was to leave for Moscow to found an institute of genetics at the Pavlov Institute in Leningrad, he walked up the Schneeberg, sat down next to the Theresa Rock, and shot himself through the left temple with his right hand. (In spite of the basic tragedy, Koestler shares with us his appreciation of the "Byronic" nature of this gesture, so characteristic of Kammerer the man.)

No one is sure to this day whether his suicide was due to the apparent discrediting of his most celebrated specimen, the decline in his personal situation because of the rampant postwar inflation, or the fact that a talented and fascinating but slightly aging musician—the last of the five Wiesenthal sisters to have successively engaged his affections—refused to accompany him to Moscow (perhaps because they were both married to other people).

This reviewer put the book down with his mind whirling in rhythm with the distant strains of this tale from the Vienna Woods. Obviously one admires Koestler's skill and economy as a storyteller. Even more perhaps, one is grateful for his ability to understand science and scientists and for his interest in

them. One can't help wishing, in fact, that more novelists were trained as engineers or had spent some time reporting scientific explorations of various kinds. Even though Koestler concentrates here on the seamier side of science, he succeeds in revealing scientists as human beings, engaged in an intensely human pursuit. Indeed, one can read the book simply as a study of how a single, vindictive man (William Bateson), disturbed by a threat to his own hard-won orthodoxy, can lure an unsuspecting and fundamentally decent person into a one-sided and fatal duel on ground of his own choosing.

Koestler, who started his investigations on the assumption that Kammerer had been guilty of some kind of deception, ultimately became convinced that Kammerer had been framed—partly by Bateson's skill in concentrating the entire argument on his opponent's weakest point and partly by an unidentified personal enemy who deliberately and clumsily tampered with the key specimen in order to make it look a forgery. This view is documented with the care and skill of an experienced attorney for the defense. Indeed this thesis appears as the principal purpose of the book and justifies the statement on the jacket that it has all the excitement of a detective story. But there are other levels at which one can read it.

Quite obviously the author wished to remind us that scientific orthodoxy is as oppressive as any other orthodoxy, but the story does not convince one that William Bateson, or anyone else, succeeded in suppressing the truth in any general sense. Surely Mr. Koestler realizes that our views on the nature of evolution did not really turn on the nuptial pads of a single male midwife toad. Even if the entire corpus of Kammerer's work were repeated and proved to be factually correct, there would still be grave questions of interpretation to be worried over—as Koestler himself hints in several places.

Possibly, perhaps even probably, he is trying to prepare us for his forthcoming book on extrasensory perception, to which he has given increasing attention during the past several years. Tucked away in the closing pages of *The Case of the Midwife Toad* is an intriguing ap-

ıendix dealing with Kammerer's ›ook entitled *Das Gesetz der Serie*, ›ublished in 1919, which contains lmost a lifetime collection of examples of coincidences, along with an ffort at classification and the development of a theory of "lawful recurrence" of highly improbable vents.

Engaged by the very richness of he possibilities opened by Koestler's treatment of this personal story, I must confess to carrying away, as my main impression, a ıeightened consciousness of what he Western world lost when Vienna lost its hinterland in World War I and its soul in the events that ed to World War II. Kammerer was what the more sober Anglo-Saxon has come to regard as the ypical Viennese, charming as well as capable, vivacious as well as industrious, brilliantly successful and, n the end, tragically defeated. There is an elusiveness, a residual ambiguity about his life that infuses much of the immense creativity of Middle Europe. One thinks of Gall and Spurzheim, the inventors of phrenology. Looked at from one angle, they are simply unusually elegant charlatans, but they may equally well be regarded as the inspired founders of a neuroanatomical tradition that underlies nearly two centuries of effort to localize functions within the nervous system. Or consider the even more dubious Mesmer, whose work on animal magnetism can be traced to Paris and Charcot, and back again to Vienna for full flowering in the psychoanalysis of Freud.

Those of us who learned our science in English are instinctively put off by the romantic dash and popular acclaim that characterized Kammerer's early visits to America. Perhaps Mr. Koestler is trying to tell us, among other things, that the baroque glitter and sometimes fantastic speculations of the culture of Middle Europe have some necessary connection with its extraordinary creativity in the arts and sciences. One remembers, for example, that although Paul Kammerer's ideas about inheritance never quite come off, the equally unlikely speculations about how the nervous system grows, elaborated by Paul Weiss from the same Viennese institute a few years later, are succeeding brilliantly.

How can one help being grateful to Arthur Koestler for reminding us of all this, and how can any American biologist who has more than a shopkeeper's interest in his subject fail to read him?

Dr. Robert S. Morison is professor of science and society at Cornell University, Ithaca, New York.

More Reviews

MY LAND IS DYING, by Harry M. Caudill. *E. P. Dutton & Co., $6.50; 144 pp., illus.*

Seldom have I read a book that so effectively communicated its author's love for his corner of this country, in this instance the Cumberland region of Kentucky. At the risk of stirring up a hornet's nest, let me simply say that lawyer-author Caudill's feeling for the area struck me as being genetically built into him. I doubt that the environmentally acquired training in law and composition would have allowed him to be quite so forceful an advocate had not the Caudills been Kentucky people since colonial times. Read the book and decide the point for yourself; the experience will be worth it in any event.

History buffs will enjoy this book because, with a disciplined economy of words, Caudill relates how the early settlers poured through the Cumberland Gap, how the hardwood forests were consumed during the post-Civil War industrial boom, how tunnel mining kept the natives employed for a time, and then how, after World War II and the decline in the demand for coal, the area relapsed into an economic backwater. By the thousands, the mountain folk migrated to the cities of the Midwest where, unskilled in the arts demanded in our technological era, they have come to constitute the urban white poor who so far have not attracted much attention.

More recently, the demand for cheap electricity has increased the demand for coal. TVA, for example, exhausted its supply of water power and, hell-bent on its mission of providing electricity at a profit to the public, went in search of coal. Private power companies, discouraged with the failure of nuclear plants to come to practical fruition, have been building coal-powered generating plants by the score. Entrepreneurs have learned, moreover, that profits can be made by employing machines in lieu of men—machines never go on strike for higher wages. The concatenation of these several factors coalesced in a boom in strip mining adventures in eastern Kentucky, the exploitation of which promises to reduce this hauntingly lovely area to a wasteland.

The most telling points Caudill makes refer to how the formal institutions of organized society have failed to come to grips with this environmental threat. The mining operators acquired their rights by buying up old mineral deeds executed years ago by the illiterate natives of the region. When it comes to interpreting these old deeds, most courts have restrained mining concerns, not allowing them to heap slag in piles so high they threaten, if they slide, to bury the homeowner on the site. Kentucky courts actually reversed their old rules and liberally construed these deeds so as to license the operatives to behave barbarously, not excluding excavating the coffins of dead children without one iota of civilized regard. TVA, once a liberal dream, continues to make a profit by not coercing its suppliers to behave better. The state legislature, while eager to enact laws requiring the mine operatives to restore the areas they have stripped, have been loath to insure the actual enforcement of these laws. As it is, the natives, scratching out a miserable existence between welfare payments and dirt farming, have resorted to rifles and dynamite to express their anger.

As a lawyer used to urban realities, I could easily enough be cynical about a book like this. Give the local landowners some rights and the lawyer who represents them stands to make a fortune himself, prosecuting lawsuits against the mine operatives. With Caudill, however, this would be an unfair innuendo. Caudill has fought for the natives and has lost all the way. If

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conomic gain were his motive, he vould have had enough sense to witch sides a decade ago. We are iot dealing here with a city lawyer.)isturbingly enough, we are met iere with the Tory-style lawyer ibout whom James Gould Cozzens ould have constructed a magnifi- ent novel. We are met with a man vho still loves his land, his hills, his rees, his home. Yet, and here is the eal tragedy, we are met with a oser.

Implicit in this book is the theme hat it is we who are the real cul- rits. Used to our electric tooth- rushes, pencil sharpeners, and ocktail blenders, we are content to njoy nature either by taking jet rips to remote foreign climes or pe- rusing the glossy color prints in ex- pensive magazines. To his credit, Caudill does not press this point; he relies upon us to induce it from the evidence. Even more to his credit, he does not lose his composure and scream to the rafters that, somehow, he has a magic answer for this mess. Rather, and here is how this book rises to the level of literature, he conveys his despair. Caudill after all is a bell ringer, a very pessimistic one. The bell is tolling for us. Fanciful? Read Caudill and then reflect upon what I said here. It may really be true, after all, that the world will not end with a bang but a whimper, and in this tragic rendition of the world as it is, we have on hand at least a scintilla of evidence supporting this proposition.

E. F. Roberts
The Cornell Law School

Slaughter the Animals, Poison the Earth, by Jack Olsen. *Simon and Schuster, $6.95; 287 pp., illus.*

How to destroy an ecosystem by trying hard, may serve as a one-sentence synopsis of this angry and eloquent book about the predator-control programs in the American West. The eloquence comes through because the anger is disciplined and as deadly as a cyanide gun.

Responding to the sheepmen's indiscriminate and pathological hatred of all predators, the state and county agencies, but above all the heavily funded U.S. Fish and Wildlife Service, labor enthusiastically to exterminate wildcats, wolves, eagles, bears, mountain lions, and coyotes by shooting and trapping: with the cyanide "coyote getter," with arsenic put out in honey buckets, with the carcasses of game animals (illegally killed by law enforcement officers) impregnated with thallium and with strychnine encased in sugar pills, very effective when sown at random from the air. But the masterpiece in this line of business is the chemical sodium fluoroacetate, known commercially as "1080," which Olsen calls "a biological high explosive." There is no antidote. Even the vomitus is lethal. The long-range effects of 1080 upon the environment remain unstudied and unknown.

Especially illuminating is the symbiotic relationship that exists between wool and sheep trade associations and government field men. "Fuller Brush men selling poison," Olsen calls the latter. They actively solicit inflated damage claims. That is, they trade more poison for a high body count of dead sheep. When the predocides clear the larger wild animals out of an area, the rodents swarm in. This predictable consequence booms government budgets and requires, of course, massive rodent-control measures—another program for the wildlife bureaucracy to administer.

With the camaraderie that won the West and is now in a fair way to lose it, ecologically speaking, the stockmen and "district field assistants" (code phrase for official poisoners) lift the social glass to the myths they both live by, such as the one that affirms that the only way sheep die on the range is by predation. And they share the laughs directed at "coyote lovers" and "little old ladies in tennis shoes" (code phrase for conservationists).

Not only the field men of the Fish and Wildlife Service but also the employees of the U.S. Bureau of Land Management and the Forest Service jump when the sheep men whistle. Those who display too much zeal in upholding the law, who report too many violations, or commit the gaffe of taking a sheep rancher before a sheep-country judge, soon find themselves looking for work in some other line of endeavor.

The people of the West who do not share the "Buffalo Bill mentality" toward the natural world are discouraged and frustrated, for the

stock lobbies, Mr. Olsen declares, "have the public by the throat." If our overgrazed public lands and disappearing western fauna are to be saved, help will have to come from the east. The author praises the work done in Congress by such men as John Saylor of Pennsylvania, John Dingell of Michigan, and Sen. Gaylord N. Nelson of Wisconsin, as well as the reportage of the gallant, Washington-based organization The Defenders of Wildlife.

But Olsen does not see the light at the end of the tunnel yet. The sheep and wool associations are powerful, well financed, and greedy for that last blade of grass. And they are caught in a cultural trap: they actually believe their own propaganda. Their vulnerable point may be the despoiling of the public lands, some of which are losing topsoil at an annual rate of a ton per acre. "Your Yard—Their Sheep" The Defenders of Wildlife laconically calls existing grazing practices in its sound and color film (rental is free).

"Only the tainted western legislatures would put up with this waste of national wealth," Olsen concludes. So write to your *eastern* senator or congressman. Or, if you are moved by Olsen's fine piece of investigative reporting, you might follow the example of Paul Gilbert, an honest supervising game warden for Colorado's Department of Game, Fish and Parks. The Gilbert household boycotts lamb.

"I think there's a place for sheep," Gilbert says, "and the place is New Zealand."

GERALD CARSON

This list details the photographer or other source of illustration by page.

COVER—Alexander McD. Davis
12-20—BBC/Radio Times Hulton Picture Library
24—Steve Myers
32—Lee R. G. Snyder
33-35—Stephen Johnson; except 35 bottom—Alexander McD. Davis
36—Lee R. G. Snyder
37—Alexander McD. Davis
38—Lee R. G. Snyder; except center—Charles Walcott
40-41—AMNH after Walcott
43—Lee R. G. Snyder
44-46—Helmut Wimmer
51—Air Force Cambridge Research Laboratories
52-53—Helmut Wimmer
55—Scala
56-58—European Art Color, Peter Adelberg
59—AMNH after van Doorninck and Katzev
60-61—Frederick H. van Doorninck, Jr. and Susan Katzev
62-63—George Bass
64-65—Jean and Des Bartlett, Bruce Coleman, Inc.
66—Leonard Lee Rue III, National Audubon Society
67—Hiram Parent, National Audubon Society
68-69—Jean and Des Bartlett, Bruce Coleman, Inc.
70—James R. Simon, Photo Trends
73—Jean and Des Bartlett, Bruce Coleman, Inc.
—Peter B. Armstrong
90—Courtesy of Random House, Inc.

Suggested Additional Reading

A CHAT WITH CHARLES DARWIN

THE ORIGIN OF SPECIES. C. Darwin. New American Library, New York, n. d.

THE VOYAGE OF THE BEAGLE. C. Darwin. Anchor Books, Doubleday & Company, Inc., Garden City, 1962.

THE LIFE AND LETTERS OF CHARLES DARWIN. F. Darwin, ed. Basic Books, Inc., New York, 1959.

CHARLES DARWIN. G. de Beer. Anchor Books, Doubleday & Company, Inc., Garden City, 1965.

THE THREE-DAY AMERICAN PLEASURE TRIP

FOUR DAYS, FORTY HOURS. R. Poor, ed. Bursk and Poor, Cambridge, 1970.

THE OFF-ROAD VEHICLE AND ENVIRONMENTAL QUALITY. M. F. Baldwin. Conservation Foundation, Washington, 1970.

MAN AND NATURE IN THE NATIONAL PARKS. F.F. Darling and N.D. Eichhorn. Conservation Foundation, Washington, 1967.

BIRD NAVIGATION

BIRD MIGRATION. D.R. Griffin. Doubleday and Company, Inc., Garden City, 1964.

BIRD NAVIGATION. G.V.T. Matthews. Cambridge University Press, New York, 1968.

THE PHYSIOLOGY AND GEOPHYSICS OF BIRD NAVIGATION. D.R. Griffin. *The Quarterly Review of Biology*, September, 1969.

ORIENTATION BY PIGEON: IS THE SUN NECESSARY? W. T. Keeton. *Science*, August 29, 1969.

THE NAVY FROM CONSTANTINOPLE

NAVAL POWER AND TRADE IN THE MEDITERRANEAN: A.D. 500–1100. A.R. Lewis. Vol. 5 of PRINCETON STUDIES IN HISTORY SERIES, Johnson Reprint Corporation, New York, 1970.

A BYZANTINE TRADING VENTURE. G.F. Bass. *Scientific American*, August, 1971.

THE CHURCH WRECK OFF MARZAMEMI. G. Kapitän. *Archeology*, April, 1969.

A FOURTH-CENTURY SHIPWRECK AT YASSI ADA. G.F. Bass and F.H. van Doorninck, Jr. *American Journal of Archeology*, January, 1971.

RETURN OF THE BEAVER

A STUDY OF BEAVER COLONIES IN MICHIGAN. G.W. Bradt. *Journal of Mammalogy*, May 14, 1938.

THE WORLD OF BEAVER. L. L. Rue III. J.B. Lippincott Company, Philadelphia, 1964.

THE AMERICAN BEAVER AND HIS WORKS. L.H. Morgan. Burt Franklin, Publisher, New York, 1970 (Reprint of 1868 edition).

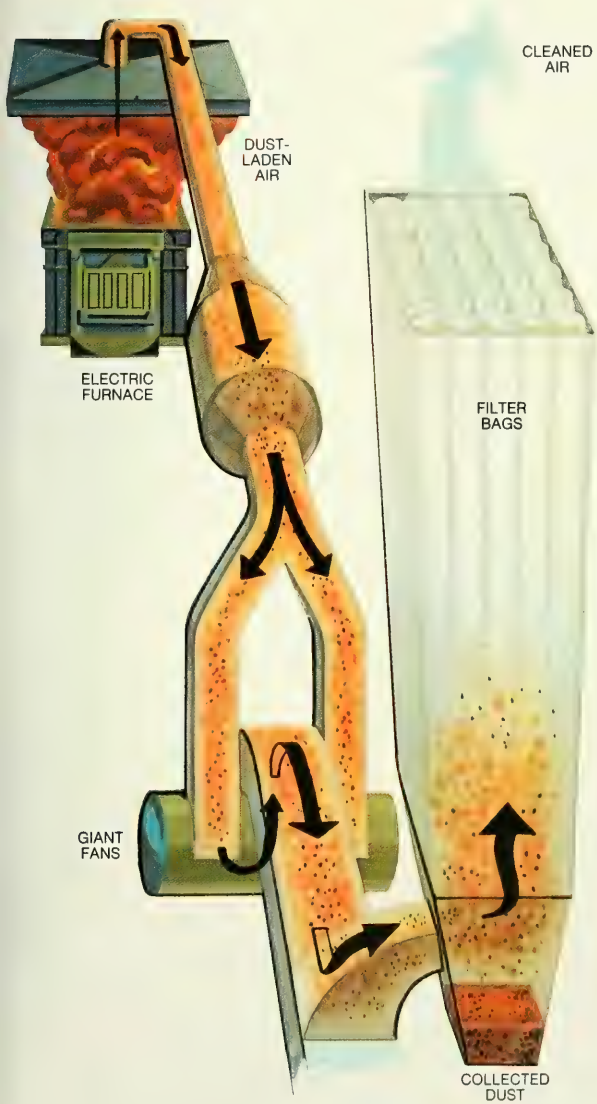
WHAT'S BITING YOU?

THE PHYSIOLOGY OF MOSQUITOES. A.N. Clements. Permagon Press, Inc., Elmsford, 1963.

MEDICAL ENTOMOLOGY. W.R. Horsfall. Ronald Press Company, New York, 1962.

HERMS' MEDICAL ENTOMOLOGY. M.T. James and R.F. Harwood, eds. The Macmillan Company, New York, 1969.

How "vacuum cleaners" keep our electric furnaces from fouling the air



Making steel in electric furnaces generates a lot of dust. The most effective way to keep the particles and fumes from billowing out into the atmosphere is to build a control system which we call a "baghouse". This operates on much the same principle as a household vacuum cleaner.

Such systems are very expensive to build and operate. But they work, and that's what counts. Our electric furnaces in Los Angeles, Seattle, and Steelton, Pa., all have baghouses.

The last of our electric furnaces to be so equipped is at Bethlehem, Pa., where a \$5½ million baghouse system will be in operation later this year. This will be capable of collecting 8½ tons of dust a day.

In the last twenty years we have spent more than \$200 million to control air and water pollution. Our efforts are continuing. We want to be good neighbors wherever we have plants, shipyards, mines, and other operations.

In a typical baghouse system, dust-laden air from an electric furnace is pushed by giant fans through a series of huge bags which filter the fine particulate matter. Cleaned air is discharged at the top.

Air passage in some of the bag compartments is shut off at intervals, and the bags are shaken, causing the accumulated dust to fall. The dust collected in the hoppers is removed for disposal or recycling.

BETHLEHEM STEEL

NATURAL HISTORY

AUGUST-SEPTEMBER 1972 • $1.00

When Jaguar XJ6 was named by *Road & Track* magazine as one of the ten best cars in the world, it came as no surprise to us.

That is *exactly* what we intended. We sought *excellence*—a rare quality in today's production-line world.

COMFORT

In a showroom, virtually every car is comfortable. Many makers use "showroom impression" as one of their criteria. Comfort is far more elusive, however, after a half-dozen hours at 60 or 70 mph.

That's why the seats of the XJ6 are designed to support the human anatomy at four vital points. Instead of being engulfed by the seat, you are supported by it. Correctly. Firmly.

A mark of the seats' interior construction is revealed by their exterior—you sit on first-grade English leather, hand-cut, hand-fitted and carefully matched for grain.

The fascia is hand-finished in gnarled walnut. It houses an array of instruments arranged with superb logic. A slight dip of your eyes reveals your road speed, engine revolutions and warning lights. A glance to the right scans your ammeter, oil gauge, transistorized clock, temperature gauge and fuel gauge—all in a neat row.

Below are ten rocker switches — the controls for your auxiliary systems — lined up like dominoes.

The interior is richly endowed with convenient pockets, boxes and shelves. The glove box contains a vanity mirror.

RIDE AND HANDLING

One of the old saws in automotive circles is that you can't achieve a smooth, comfortable ride *and* have a superior handling car.

The Jaguar XJ6 has laid that bit of engineering folklore eternally to rest.

Witness: *Motor Trend,* Dec., 1971. ". . . take a peek at tomorrow and promote a ride in an XJ6, the ride and handling and basic construction put it in a class by itself."

Indeed, the XJ6 *is* in a class by itself. Independent front and rear suspensions let each wheel suffer the jolts and jounces of the road surface independent of the others.

And, in addition, we have "suspended" our suspension systems on steel sub-frames, to avoid the transmission of vibration and harshness to the passenger compartment. Result: the driver and passengers are completely isolated from the vagaries of the highway.

And power assisted rack-and-pinion steering not only gives you instant response, but also a proper "feel" of the road.

The net effect is the feeling that something good has happened to the road itself. And that curves have become crisp, clean, unwavering arcs, negotiated with grace.

PERFORMANCE AND SAFETY

We believe the subjects of performance and safety are two sides of the same coin. . car that can whisk you straight as an ar from 0 to 60 should be able to bring back down to a calm, dignified stop, jus smartly.

Our performance going up the sca generated by a 4.2 litre, twin-overhead c six cylinder engine. Race-designed proven, it powers the 3,830-pound Jag XJ6 from 0 to 60 in a little under 11 seco

That's why the XJ6 has power-assi *disc* brakes. Four to be precise. 11.2-inch v tilated discs on the front wheels. 10.4-i discs, mounted in-board, on the rear. C bined with "anti-dive" geometry of the fi suspension, they give you stopping ab that's sure, straight and quick.

The center section of the body is mensely strong, while the front and r ends are designed to deform progressiv and absorb the energy of an impact. even tuck the fuel lines into the structur minimize the chance of rupture.

There are burst-proof locks on doors, in the rear we add child-proof latcl

TOLL-FREE INFORMATION

For dealer location or overseas delivery formation, call (800) 631-1972. In N.J., (800) 962-2803. And do schedule eno time to thoroughly examine one of "the best cars in the world." Considered by ma "the one best" in its price category.

JAGUAR XJ6.
It reflects the pursuit of excellence abandoned by many for the sake of expediency.

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NATURAL HISTORY

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY — INCORPORATING NATURE MAGAZINE

The American Museum of Natural History

Gardner D. Stout, President *Thomas D. Nicholson, Director*

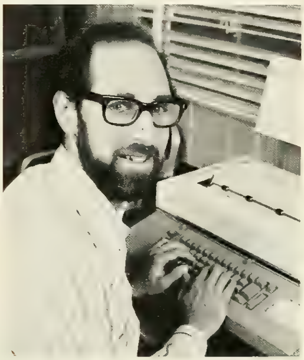
Vol. LXXXI, No. 7 August-September 1972

COVER: *A bronze incense burner from the Western Han dynasty (206 B.C.–A.D. 24) was recovered in 1968 from the tomb of Prince Liu Sheng. Smoke rising through small perforations in the lid gave the impression of mist drifting over mountain peaks.*

Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September. Subscriptions: $8.00 a year. In Canada and all other countries: $9.00 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices.

Authors

Research engineer **Eric Hirst** is studying energy-use patterns under an environmental program sponsored by the Oak Ridge National Laboratory and the National Science Foundation. The object of his research at Oak Ridge is to



Eric Hirst

identify areas where energy efficiency can be improved, thereby reducing energy growth rates and energy-environment conflicts. For eight years Hirst rode a bicycle to school and work, but he now lives too far from the laboratory to cycle. He does, however, belong to an energy-efficient car pool with three other people. Before coming to Oak Ridge, Hirst and his wife taught at the Tuskegee Institute in Alabama.

Columnist **Arthur W. Galston** and his wife entered China early in July for an extended stay. His time there will be divided between work at a research institute and an agricultural commune. This issue's column on the Chinese university is based on observations made during his previous visit to that country. It is adapted from an article published in the April, 1972, issue of *BioScience,* the journal of the American Institute of Biological Sciences.

Robert Sommer, an environmental psychologist, teaches at the University of California at Davis and is chairman of the school's Department of Psychology. His interest in zoos developed from his field work in prisons, mental hospitals, and college dormitories and reflects his concern with the behavioral

Robert Sommer

connections between people and their surroundings. This is also the subject of his recent book, *Design Awareness,* and of many of his articles. Sommer is the author of "A Time for Every Purpose," which appeared in the August-September, 1971, issue of *Natural History.*

Analysis of new data unearthed by Chinese archeological field workers has enabled **Judith M. Treistman** to clear up many misconceptions about the role of archeology in the People's Republic of China. Associate professor of anthropology at the City University of New York,

Judith M. Treistman

she has written numerous articles and reviews on Oriental archeology, as well as *The Prehistory of China,* which was recently published by the Natural History Press. Treistman has done field work on Taiwan and research on Chinese art collections in the United States.

An associate professor of psychology at the University of California at Davis, **Dale F. Lott** was born on the National Bison Range in Montana and spent most of his childhood on or near it. His curiosity about bison was not very intense, however, until he needed a suitable animal for a field project. He felt that because bison "were such a prodigious success in their time, they should offer some valuable insights into the questions concerning the adaptive significance of animal behavior." Lott plans to continue his research project on the

The Hasselblad 500 EL/M. It brings the concept of "Film Director" to 2¼ photography.

The Hasselblad 500 EL/M is the only electrically-driven 2¼ camera. After you take a picture, the 500 EL/M advances the film and cocks the shutter, readying itself for the next shot automatically. This allows the photographer to concentrate less on the mechanics of the camera and more on composition. And because it can be triggered remotely in a variety of ways, the 500 EL/M opens some interesting possibilities. It lets you get out from behind the camera and work with your subject. In a sense, it permits you to become more a director than a cameraman.

Picture this.

SCENE ONE

You're an advertising photographer and you have to shoot a group of kids. You take your Hasselblad 500 EL/M, snap on a 70-exposure film magazine and a Zeiss Planar 80mm f2.8 lens. You slide off the waist-level viewing hood and slip on an eye-level prism finder with through the lens metering system. Now you set up the camera on its tripod and attach a 100-foot release cord, wound on a cord reel. You focus, set your speed and aperture, then walk away from the camera to work with your subject. You shoot as you work, no distracting the kids by the presence of the camera.

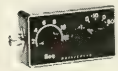
SCENE TWO

You're a medical photographer filming an operation. You set up two Hasselblad 500 EL/Ms on tripod mounts, each covering a different angle. Again you use a 70-exposure magazine on each camera with different film, but this time you change to Zeiss Sonnar 150mm f4 lenses, with appropriate filters. You preset the controls, then plug the two cameras into a single command unit (this unit can handle four Hasselblads at once).

You attach a release cord to the command unit, and you're ready to trigger both cameras simultaneously throughout the operation.

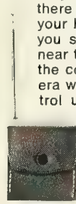
SCENE THREE

You're an industrial photographer and your assignment is to photograph instrument readings at pre-determined intervals over a period of time. You change to a Zeiss Distagon 500mm f4 lens. Then you connect the Hasselblad to its timer and set the timer to trigger the camera at the desired intervals. You pre-set the camera, start the timer, and leave. When the time comes, the intervalometer will trigger the camera. It operates off the same rechargeable batteries that will automatically ready the camera for the next shot. There's no need for the two of you to hang around waiting. Only the camera.



SCENE FOUR

You're a wildlife photographer and you're out to get pictures of an animal that would just as soon eat you as pose for you. So instead of going after the animal with your Hasselblad, you arrange to have the animal come to you. And not find you there when he arrives. Only your Hasselblad. To do that you set up your 500 EL/M near the water hole, pre-set the controls, equip the camera with a remote radio control unit, and put distance between yourself and your Hasselblad. You watch through binoculars, and when the animal appears, you trigger the camera by radio signal, shooting up to 70 exposures, without a scratch.



Of course, a good many photographers simply don't have the occasion to use the 500 EL/M remotely. They use it hand-held or tripod-mounted. Or, like the American Astronauts, attached to their chest packs.

The 500 EL/M, as remarkable as it is, is only one camera of the Hasselblad System. For information on the other Hasselblads and their extensive accessories, write for our free catalog. Paillard Incorporated, 1900 Lower Road, Linden, N.J. 07036. Other products: Bolex movie equipment, Hermes typewriters and figuring machines.

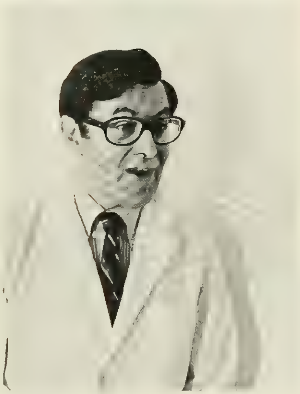
HASSELBLAD®

The System

Dale F. Lott

social behavior of bison and to study the effects of experience on behavior and the effects of social stimuli on reproduction endocrinology.

Before the tide of human overpopulation can be stemmed, **Gerald Oster** believes researchers will have to find birth control devices that are safer and more widely acceptable, especially to the people of the less developed countries. Pursuing this aim at the Mount Sinai School of Medicine of the City University of New York, where he is professor of



Gerald Oster

biophysics and research professor of obstetrics and gynecology, Oster has been experimenting with copper-wired intrauterine devices and various chemicals that suppress the transport of sperm in the cervical mucus. In addition to his broad scientific career, Oster created the mathematical art known as moiré patterns, and has had exhibits at the Museum of Modern Art in New York and at numerous other museums. While lecturing on the subject, he is enveloped by a projection of one of his designs, left below.

By studying the roles of age, family dental history, population trends, and genetic factors in the dentition of Michigan schoolchildren, **James E. Harris** has been able to improve the prognoses for orthodontic treatment. He was able to test and refine his theories by comparing what he found among present-day Nubian children with the skulls of their ancestors of

James E. Harris

2,000 years ago. To study the effects of dietary differences, he next compared the dental histories of the ancient Nubians with those of higher-class Egyptians of the same era: first, the officials and nobles, and finally, the pharaohs, themselves. Harris is professor of dentistry and chairman of the Department of Orthodontics at the University of Michigan.

The coauthor of "X-raying the Pharaohs," **Kent R. Weeks** is an Egyptologist trained in anthropology and archeological techniques. With Harris, he has attempted to learn more about ancient Egyptian medicine, health, and disease through X-raying the royal mummies. Their studies have unraveled some of the mysteries of the process of mummification, as well as the times and causes of death of the subjects. Weeks reports that their findings have "seriously affected many of the views of Egyptian culture often taken as fact." An associ-

Kent R. Weeks

ate professor at the American University in Cairo, he is the author of a text, *The Tomb of Pernab*, scheduled for publication by the Metropolitan Museum of Art in New York.

The writer-photographer team of **Bob Skovbo** and **Paul von Baich** has published several accounts of their travels through Alaska and Canada, including two previous articles for *Natural History*. Skovbo, who writes under a pen name to assure the anonymous travel he pre-

Bob Skovbo

fers, first crossed parts of the remote Ogilvie Mountains of the Yukon in 1969, and was so impressed by what he saw that "I decided to return with my old traveling companion, Paul von Baich, whose lenses could do the landscape better justice than I could." Their backpacking trip into the area last summer revealed a wilderness laced only with the abandoned cabins of Gold Rush sourdoughs, and mountains unlike any they had ever seen.

Letters

Good and Bad News

It is with pronounced relief that I report that both Larry Strickland and David Smart ["A Resurgence of Rabies," May, 1972] have passed the reasonable period of incubation for rabies without developing the disease.

It is with considerably less enthusiasm that I convey the findings of the Center for Disease Control rabies surveillance staff for 1971: 4,392 laboratory-confirmed cases of rabies reported for the United States, 1,116 more cases than in 1970 and 14 percent above the average for the preceding five years. This was also the first year that rabies was reported from all contiguous states.

NORMAN FRANK
Public Health Veterinarian
Dade County, Florida

Norman Frank's "A Resurgence of Rabies" was a timely item coming as it did prior to the camping season, when many thousands of campers, trailerites, and other nomads on wheels—with their dogs—move into and around the normal habitat of wildlife species whose individuals may be a source of the dreaded virus. While a half-dozen states bar dogs from overnight stays in state park campgrounds, the other states do admit them, as do most privately owned campgrounds and trailer parks. Where dogs are permitted there is nearly always the precaution: "Pets on Leash Only." Unfortunately, the leashing requirement is not universally observed. Strict adherence to the rule would largely prevent contact with rabid wild animals.

ROLAND BIRNN
Clearwater, Florida

A Taste Test

In "The Organic Gardener and Anti-intellectualism" in your May issue, Arthur W. Galston presents an excessively narrow view of organic gardening in order to make his "scientific" argument for chemical methods of plant culture appear more convincing.

For example, I don't argue with Galston that it is possible to grow plants in chemical solutions. However, such hydroponic methods are so costly in both dollars and resources that surely large numbers of Americans would starve if these methods were our only source of food production. The true advantage of the organic system is that it takes a much more whole view of the growing of food than Professor Galston is willing to look at. I think he could benefit from reading Barry Commoner's book *The Closing Circle*, which explains quite lucidly the ecological necessity of returning organic materials to the soil and the problems that result when agriculture becomes dependent on synthetic chemicals.

Also, I challenge Galston's statement that "such [hydroponic] plants are as capable of supporting the growth of the animals that eat them as are 'organically grown plants.'" I know of no such test that has ever been conducted comparing hydroponic with organically grown foods. To find the true worth of food, it is necessary to conduct nutritional experiments over a long period of time, so that the effect of trace element and other nutritional imbalances can be observed over several generations. Fortunately, such tests are now being planned and will probably be carried out shortly.

Actually, the many young people who are now interested in natural and organically grown foods need go no further than their own taste buds to gather acceptable data on food quality. They like the way natural and organically grown foods taste, as compared with the conventional foods, which are so overprocessed and gimmicked up with additives.

ROBERT RODALE
Emmaus, Pennsylvania

Against Clearcutting

I am shocked to find an advertisement transparently aimed at deceiving conservationists in the pages of your fine magazine. I am referring to the American Forest Institute's "I'm Clearcutting to Save the Forest" advertisement in the May, 1972, issue.

As a student of geology, I recently wrote a paper summarizing the geologic effects of clearcut logging. The scientific evidence, gathered by researchers working in forests in various parts of the United States, specifically including Oregon, shows without any doubt that clearcutting is destroying the productivity of our forests (our national forests, I might add). The rate of regrowth in clearcut areas is simply not as great as that predicted by foresters.

One of the major causes of this declining productivity in clearcut forests is the actual removal of soil due to tremendously increased erosion rates. Peaks of sediment concentration more than 250 times those observed in an uncut watershed were measured in a stream in Oregon. The burning of slash (the debris remaining after the logs are removed), so casually referred to by the beneficent logger in the advertisement, greatly increased erosion by removing any anchoring ground cover. This erosion not only removes the fertile topsoil from our forests, but also clogs streams and pollutes them with nutrients. Spawning gravels, necessary for salmon reproduction, are destroyed by the deposition of fine material from the soil. It may be years before these stream beds can once again be used by the salmon. Salmon and trout are also detrimentally affected by the increased stream temperatures (and decreased oxygen content) observed in streams draining clearcut areas.

A newly discovered and highly disturbing effect of clearcutting is the flushing of nutrient ions from the soil. It seems that a proliferation of the bacteria that convert insoluble NH_4^+ into soluble $NO_3^=$ follows the removal of vegetation. The flushing out of the nitrogen is closely followed by the removal of other important ions. The result is a severe depletion of the soil and pollution of streams.

There is a hopeful note. The amount of disturbance observed in an area is closely related to the care taken in logging. Carefully planned roads, buffer zones of trees along stream banks, and careful selection of trees to be cut help to protect and preserve our land. Our forests deserve better treatment than clearcutting.

ELLEN Z. HARRISON
Sharon, Connecticut

With regard to the American Forest Institute advertisement, one can rejoice in our good fortune that forests had somehow managed to survive until the loggers arrived on the scene to begin saving them.

GLEN COLE
Chicago, Illinois

To Observe an Eclipse

May I add to your interesting articles on the total solar eclipse [June-July, 1972] that on February 26, 1979, a total eclipse will be visible in the states of the Pacific Northwest. Thus, Americans will have another chance to see an eclipse without traveling too far.

I have always been amused by the heights to which astronomers will go to observe an eclipse. The altitude record mentioned was exceeded by Professor D. E. Blackwell of Oxford during the eclipse of June 30, 1954. In the *Monthly Notes* of the Royal Astronomical Society (1955, page 630), he writes:

> The observations should be made in an open aircraft, and not through an aircraft window. . . . If a special window is fitted, there is danger of frosting at high altitude. In making the observations now being described it was found most convenient to fold the aircraft door back to mount the camera in the open doorway. . . . The aircraft used was a special Lincoln capable of flying to an altitude of 43,000 feet. Physiological difficulties made it inadvisable to attempt observations from this height, and a height of 30,000 feet was chosen to give the best compromise between sky darkening on the one hand, and aircraft stability and observer alertness on the other hand.

I nominate this for the award for British and scientific understatement.

JAY M. PASACHOFF
Williams College–Hopkins Observatory

Food for the Eye

Alan Dundes's perceptive article on the sensory dominance of vision omitted perhaps the most curious American phenomenon of all—the Playboy Clubs, where the objective seems to be to spend the evening viewing the waitresses. At least they are seen first-hand. We may yet live to see restaurants where the finest food is brought forth, displayed to the customer's discerning eye, and then returned to the kitchen.

KENNETH M. SMITH
Newark, Delaware

Liberating the Straw Woman

Marvin Harris's "practical suggestion" vis à vis the liberation of women (and consequently men) ["Women's

The ideal

We must teach our children not only what to see but *how* to see.

artist: herbert bayer (1934)

The real

Too often we try to educate by preaching orthodoxies. But orthodox solutions are no longer enough.

Our world is changing faster than ever before while many of our educational premises remain static, mired in the past.

But the past no longer has enough of the answers. In the years ahead, problems will arise for which there are no precedents. To keep the future open we must teach our children not only what to learn but *how* to learn, *how* to see, *how* to analyze.

Only then will they be able to recognize and cope with problems which our generation cannot even foresee.

AtlanticRichfieldCompany

artist: jasper johns

GOINGS ON ABOUT TOWN

S	M	T	W	T	F	S
			26	27	28	29
30	31	1	2	3	4	5

THE NEW YORKER

THE TALK OF THE TOWN

Notes and Comment

...If the charcoal these women use still contains traces of the dioxin contaminant—or if, as some scientists have reported, the burning of 2,4,5-T can itself produce dioxin—they are running a risk of ingesting quantities, though small, of one of the most poisonous and teratogenic substances known....

THE SPORTING SCENE

MAINLY ABOUT JONES

...The odd thing about the 1972 Masters was that it started out as if a memorable tournament were in the offing. In the first round, for example, one of the great figures in American folklore, Samuel Jackson Snead, posted a three-under-par 69, which placed him only one shot behind the leader, Jack Nicklaus, and there was such snap to Snead's stride and such verve to his golf that although we all knew he was born in "19 and 12," as he puts it, and will turn sixty this May, he had the look of a true contender....

—HERBERT WARREN WIND

THE CURRENT CINEMA

Alchemy

IF ever there was a great example of how the best popular movies come out of a merger of commerce and art, "The Godfather" is it. The movie starts from a trash novel that is generally considered gripping and compulsively readable, though (maybe because movies more than satisfy my appetite for trash) I found it unreadable....

—PAULINE KAEL

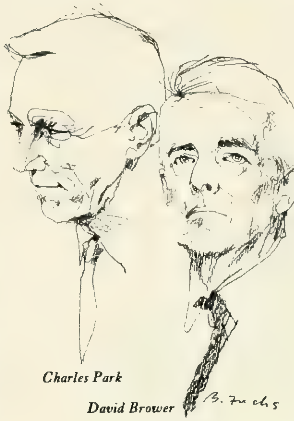
LETTER FROM WASHINGTON

...Wallace captured most of the Florida delegation not because he got most of the primary votes but because the majority of ballots was divided among ten other candidates, all of whom were liberals of one species or another, and some of whom differed in nothing noticeable except physiognomy....

—RICHARD ROVERE

PROFILES

ENCOUNTERS WITH THE ARCHDRUID



Charles Park

David Brower

...Brower had dropped out of college when he was nineteen, and disappeared into the Sierra Nevada. He had spent his life defending mountain ranges and what, by extension, they symbolized to him, and one of the ironies of his life was that his love of the mountains had long since drawn him away from them and into buildings impertinently called skyscrapers, into congressional corridors, into temporary offices in hotel rooms, into battle after battle, and out of shape....

—JOHN MCPHEE

OUR FAR-FLUNG CORRESPONDENTS

THE POLLUTION OF LAKE BAIKAL

...Because a large part of Lake Baikal's watershed area is surfaced with rock, its water is between twenty-five and fifty percent lower in mineral content than that of most freshwater bodies, and is so transparent that divers can see down almost a hundred and fifty feet. These and many of the lake's other unique attributes and resources have, for the past ten years or so, been increasingly threatened by the incursion of industry....

—MARSHALL I. GOLDMAN

"I think I know what's causing your migraine."

A REPORTER AT LARGE

THE CLOSING CIRCLE—I

...The paradoxical role we play in the natural environment—at once participant and exploiter—distorts our perception of it. Particularly serious is the illusion that we have "conquered nature" and no longer depend on the natural environment....

—BARRY COMMONER

Fib," May, 1972] is a perfect sequitur for his straw man (woman!) statements. Leaders in the movement do not, as Mr. Harris suggests, take the singular position of the denial of the "existence of deterministic natural and cultural processes that might account for female subordination."

They challenge the notion as unsubstantiated, and if it were substantiated, they would condemn it as archaic and irrelevant. He asks, "But what is there to look to outside of nature?" Must this anthropologist be reminded that the quintessence of humanness resides in our capacity to amend the natural forces that shape our lives? Continuing his assault on his straw woman, Mr. Harris says, "Women control the nursery and the early childhood conditioning of both sexes." That is to say, subordinated, brainwashed women. It is precisely that kind of woman, programmed meticulously to support and teach male values and wishes—total male culture—whom today's liberationists will free.

CLYDE TRUDEAU
Fairfield, Connecticut

Incident in the Serengeti

My attention has been drawn to a statement by George B. Schaller in the conclusion of his superb series on the predators of the Serengeti [February, March, and April, 1972]. Mr. Schaller unequivocally states that "zebra sometimes defend their offspring against cheetah, wild dogs, and hyenas but not against lions."

I returned from the Serengeti last March and was privileged to witness an incident that, although rare, may change the absolute validity of Mr. Schaller's statement.

My colleagues and I were observing a herd of zebra from four Land rovers in the Ngorongoro Crater. A lioness appeared from some nearby brush and, using the cars as cover, stealthily approached the zebras. At this point it became obvious that the lioness had not only accepted the daily presence of tourists, but that she had also adapted to using their vehicles as cover. Finally, having selected a mare and foal as likely prey, the lioness sprang upon them and made a clean kill of the foal, apparently breaking its neck. The remainder of the herd ran around in disorganized fashion, except for the mare, who returned to the kill and seized the lioness by the neck. There ensued about twenty seconds of absolute excitement, during which time the zebra had much of the advantage and we were able to record the incident on movie film and also obtain other pictures. The encounter ended when the lion finally broke loose from the mare's jaws and succeeded in inflicting some facial lacerations. The zebra retreated to the herd and the lioness removed the carcass of the foal to a wooded gully, where her cubs were located.

This is undoubtedly an unusual experience, and I wonder if any of your readers have encountered a similar situation.

C. BRIAN BURKE, M.D.
Hitchcock Clinic
Hanover, New Hampshire


adidas
ITALIA

In Praise of Bikers, Hikers, and Crowded Cars

How long can we afford the luxury of large, single-passenger automobiles?

by Eric Hirst

The automobile is assuming an ever increasing role in the social life, the economy, and the environment of America. Environmental problems associated with the automobile include air and noise pollution, traffic congestion, urban decay, suburban sprawl, and the lack of adequate transportation alternatives, such as mass transit systems.

During the past few years we have also been confronted with a series of energy problems, often referred to as an energy crisis: brownouts and blackouts, fuel shortages, rising fuel prices, and the environmental impacts of energy production and conversion. Unfortunately, many of us are not aware of the close relationship between the automobile and these energy issues.

Approximately one-half of United States energy consumption is supplied by petroleum, with half of this petroleum going to the transportation sector. In 1970, American cars consumed 66 billion gallons of gasoline, equal to 30 percent of total United States petroleum consumption. This is important for three reasons.

First, the United States currently imports almost one-fourth of its petroleum supply. The fraction of oil provided by foreign imports is climbing rapidly and will probably exceed one-half within ten years. Most of this oil comes from the Middle East, a region noted for its political instability and lack of amity for the United States.

Second, development of petroleum supplies involves serious environmental problems. Consider the number of oil spills, tanker accidents, fires at offshore oil wells, and the controversy over the Alaskan oil pipeline.

Third, the world supply of petroleum is quite limited, and we shall soon face a serious energy resources problem. Experts estimate that 80 percent of the world oil supply will be exhausted within fifty years. United States petroleum resources are sufficient for only another thirty to forty years; even the Alaskan oil discoveries cannot add more than ten years to these estimates.

But gasoline consumption by automobiles is only part of the problem. Indirectly, to manufacture, sell, and maintain it, the automobile consumes as much energy as it consumes directly in gasoline.

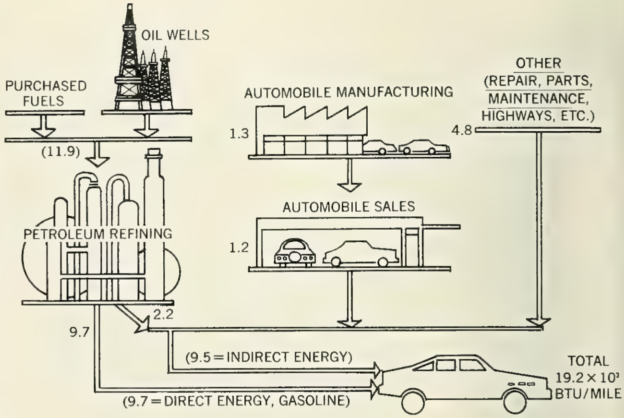
Automobiles are made of steel, iron, copper, aluminum, rubber, glass, plastics, and other materials. These materials must be mined, converted from raw ore to a primary product, then finished at a fabrication plant. These finished products are then shipped to automobile factories, where automobiles are assembled. Each of these steps requires energy. All together, to manufacture one automobile it takes about 150 million Btu. (British thermal units) of energy, which is the equivalent of 1,100 gallons of gasoline. This is enough gasoline to run a car for about 15,000 miles.

Energy is also required to ship cars from the factories to dealerships throughout the country. Dealers expend energy preparing cars for delivery, advertising their wares, lighting and heating their showrooms, and so on. These various activities require almost as much energy per automobile as does the manufacture of a car. We must also include the energy used to make replacement tires, spark plugs, batteries, and all the other parts needed for repairs and maintenance and as accessories.

Once the automobile reaches the consumer, it must be powered. In order to produce a gallon of gasoline, oil fields must be discovered, wells drilled, oil pumped to the surface and transported to refineries. Petroleum refineries consume energy to transform crude oil into various refined petroleum products, such as gasoline, diesel fuel, kerosine, and jet fuel. Totaling the energy costs for these steps suggests that about 1.2 units of energy are required, directly and indirectly, to produce 1 unit of gasoline energy. In other words, the energy equivalent of 12 gallons is consumed for every 10 gallons pumped into your car's gas tank.

Finally, billions of dollars are spent annually to construct new highways and roads. This requires considerable quantities of energy, both for the construction itself and for the production of the sand, gravel, and cement used to build these roads.

In 1968, for example, all these energy requirements added up to a total of about 16,000 trillion Btu. Of this total, only 50 percent was consumed directly as gasoline; the



remainder was devoted to indirect functions. The average automobile in the United States consumes 19,000 Btu. per mile. This is equivalent to only 7.1 miles per gallon of gasoline.

Thus, the automobile is responsible, directly and indirectly, for about 25 percent of the total United States energy consumption. What can we do to lower this figure, conserve energy resources, reduce air pollution, and help solve both our energy and automobile problems? The most important thing is to promote changes in passenger transportation. Bicycles are 22 times as energy-efficient as cars, walking 15 times, buses almost 4 times, and railroads 2.5 times. Only airplanes are less energy-efficient than cars.

If we were suddenly able to shift all urban passenger traffic to buses and half the intercity automobile traffic to buses and railroads, we would effect enormous energy savings. Specifically, in 1970 we could have cut gasoline energy consumption in half, from 9,000 trillion Btu. for automobiles to 4,500 trillion Btu.

In addition to the beneficial aspects of energy conservation, such changes in transportation would have other positive effects. Traffic congestion in cities would be reduced, and land formerly devoted to parking lots and streets could be used for parks and housing. The noise of engines, squealing tires, and honking horns would be gone and we might, once again, be able to hear birds sing.

On a national scale, we would greatly diminish our dependence on foreign petroleum. These changes would also ease the pressures on domestic petroleum reserves, allowing us more time to develop ecologically rational ways to use these resources.

Unfortunately, it will take at least a few decades to shift from automobiles to more energy-efficient transport modes such as mass transit. One encouraging note, however: in 1971 more than 8 million bicycles were sold, twice the number sold ten years earlier.

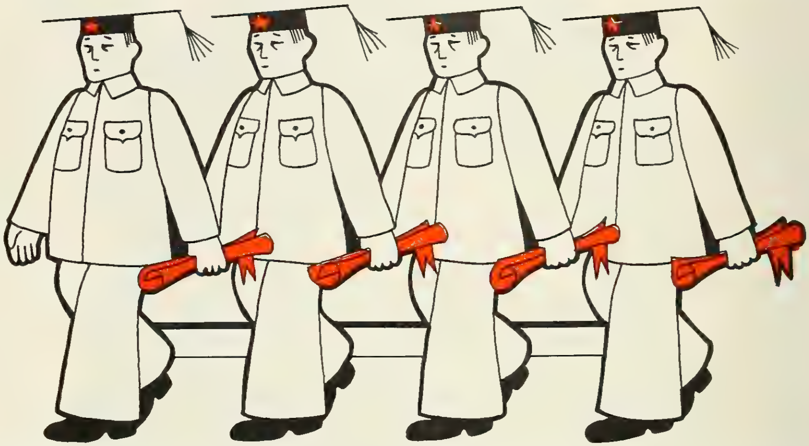
In the meantime, there are ways to increase the energy efficiency of cars. The typical car carries only two passengers; if this number were increased to four, energy consumption for automobiles would be halved. We could also use smaller cars, with low-horsepower engines, driven at lower speeds to improve fuel economy. For example, a Vega with four passengers uses only one-fourth as much fuel per passenger mile as a large Buick with two passengers.

Some of these gains, however, will be offset by a probable decline of 20 to 40 percent in fuel economy over the next several years; to meet the new federal automotive air quality requirements, car engines will use more gasoline to clean up their exhaust.

The changes in passenger transportation suggested here would require modifications of many elements of our society. But this should not deter us from considering such changes. After all, consider the alternatives. ■

by Arthur W. Galston

The Chinese University



Shunning competition and grades, the students work together, are promoted together, and "not a comrade is left behind"

In the post-Cultural Revolution People's Republic of China, the university is so different from its American counterpart as to be virtually unrecognizable as the same entity. To understand the nature of the Chinese university of today requires some understanding of Chinese society, for in China, as almost nowhere else in the world, the university mirrors and serves the needs of its society.

For centuries, a weak and disunited Chinese nation had been ravaged not only by internal strife and corruption but also by repeated imperialist invasions. For a decade before Pearl Harbor, China had been occupied by, and was fighting a fierce guerrilla war against, Japanese invaders. Then, following the defeat of the Japanese in 1945, she suffered through an additional four years of bitter civil war. With the establishment of a Communist government in 1949, China was deprived of contact with, and aid from, the Western powers and was, up to 1960, almost totally dependent on the Soviet Union and eastern European countries for technological and scientific assistance. Following the ideological split with the Russians in 1960, even that aid has been largely denied to her. Since 1960, whatever progress China has made in solving her pressing problems of production, public health, and technology has been accomplished almost totally with her own resources.

Possessed of this capsule of recent Chinese history, and knowing also that for centuries China has been bedeviled by such ills as overpopulation, underproduction, starvation, disease, alternating floods and droughts, child selling, concubinage, and prostitution, what should the modern traveler in China expect to find? I was astonished from the very first moment of my entry into that country. Immediately overwhelming is the impression one gets of a well-fed, healthy, adequately clothed, reasonably well-housed, and enthusiastic population, working together vigorously to improve their lot in life. The cities are incredibly clean, neat, and orderly, and the roadsides are lined with trees. The countryside, formerly a patchwork quilt of small farms incapable of efficient production, has now been organized into huge collectivized communes where tens of thousands of people work cooperatively to achieve greatly enlarged production. In the cities, factories and dwellings are similarly well organized.

The main thrust throughout China is a determined effort to achieve a greatly increased standard of living. China has much to teach the Western world about the organization of production, public health, and cooperative living units. As an

ancillary feature, it offers new insights into the organization of the university to meet the needs of its people in this critical stage in its history. While the Chinese model may not be relevant to the American scene, it may be very relevant to the problems of emergent Third World societies, which are seeking to leap from a preindustrial, underdeveloped, often postcolonial organization into the modern twentieth-century technologized world.

The Chinese student graduating from secondary school, at about the age of 18, does not immediately enter the university. He must first go on to the production line—in a factory, in a commune, or in some branch of the People's Liberation Army. This last organization is not entirely military. Besides the militia, it includes activities like our Peace Corps, Civilian Conservation Corps, Public Health Officer Corps, and apprentice teachers. It seems to be a means of obtaining national service from the young under a variety of agencies and conditions.

Following about three or four years of successful and productive service, the student may be nominated by his production unit for entry into a university. Only those students who indicate a desire to attend the university, who have done well in their studies, who have demonstrated a knowledge and appreciation of Marxism-Leninism and Maoism, who have demonstrated their social concern and willingness to subjugate their individual ambitions to the needs of the people, and who indicate a desire to be leaders in their community will achieve recognition by being nominated for admission to the university.

The entering student is generally somewhere in his mid-twenties. He has already had experience on the production line, is mature, and has some appreciation for his position in society.

One of the main effects of the Cultural Revolution has been to terminate the concept that the university is a means of escaping from the life of the laboring classes. Rather, the university and the courses that it offers are considered a means of obtaining expertise that will permit the student to return to the production line as a more intelligent and expert laborer, frequently in the same unit from which he came.

Thus the purpose of his education is to permit him to better serve the people by becoming acquainted with that body of organized theoretical and practical knowledge relevant to the job that he has been doing. It is easy to see how this works in the sciences; much less clear to me is what happens in the liberal arts, humanities, and social sciences. The over-all effect of this policy is to prevent social stratification in which the laboring classes are separated from the expert or managerial classes.

At Chungsan University in Canton, for example, the university has set up departments of industrial biology, agricultural biology, and herbal medicine, instead of the usual Department of Biology. The industrial biology program has as its focus a factory—built cooperatively by students, professors, and laborers—for the production of tetracycline antibiotics. The principles of biology, chemistry, engineering, and even economics are taught within the framework of learning to grow the mold, to extract and characterize the antibiotic materials, to test and calibrate them, and then to put them up into glass ampuls that will be acceptable to the medical profession. So effective has this system been that the profits realized from the sale of materials to the government have permitted this department to build a new laboratory, which it hopes to put into production shortly. It will extend the department's program to other fermentation products such as the plant growth hormones, the gibberellins.

How was all of this organized, and who made the decisions? One learns quickly that in the new China, all decisions are made by tripartite Revolutionary Committees, which run everything from factories and universities to municipalities. All such committees consist of political cadres, members of the People's Liberation Army, and representatives of the workers in the particular installation. They seem to be elected through reasonably democratic techniques in the organizations that they serve. These organizations were formed during the Cultural Revolution, and seem to be reasonably well adapted to the needs of the people during these times.

The content of curriculum of individual courses and of educational methods would be decided not by professors alone but by a group of professional and lay people, discussing not only the subject matter but the needs of society, as well. This, of course, leads to a very practically oriented curriculum, and I think it is fair to say that there is essentially no basic research going on in China at the present time, either in universities or in the various agencies of the Academia Sinica. However, the Chinese do read the world's literature and are content, at least for a while, to let the rest of the world do the basic research upon which they will depend for their practical advances.

The student admitted to the university is given a stipend of 19.5 yuans per month. This is about one-third of the average wage of factory workers and permits the students to exist at a level roughly equivalent to the bare subsistence that characterizes many American graduate students today. They do not have to worry about tuition; they have enough money for food, shelter, clothing, and miscellaneous supply needs, but they certainly don't have anything extra. At a dormitory that I visited at Peking University, instead of being offered the usual tea, I was offered hot water by the students who served as hosts; for them tea was a luxury. The only exception is the more mature student who comes to the university after ten years or more on the production line. Such students continue to receive the full salary they enjoyed as workers, and this is paid by their production units, not by the university.

Certain aspects of the educational process in Chinese universities differ radically from widely used and accepted practices that we deem essential to quality education. In the first place, the practice of assigning grades for performance simply doesn't exist in Chinese universities. There are examinations, but these are strictly didactic devices used to inform the student what subject matter he does not understand adequately, and also to inform the professor where he has failed to communicate well. Competition between the students is also lacking. In fact, when we asked about competition between students, we were greeted by gales of laughter. We were told that the more able students help the less able students; all work together, all are promoted together, and "not a comrade is left behind." How then does one decide who is the best student in the event that there is one position to be given, for example, to a superior physicist for a research post? How can this possibly be accomplished if no grades are kept? Once again the students laughed in response to this question. "We know who the most able students are," they said. "We, ourselves, can choose him, because after having lived together we know well who understands the subject best. We do not need a professor with a grade book to tell us." It is, of course, too soon to know how successful this experiment in ungraded, uncompetitive education will be, but that it is going on at all, and on a nationwide scale, must pose a challenge for American universities, which are so rooted in a competitive, grade-oriented system.

We have heard much in the Western world about the iniquities visited upon professors, especially those trained in the West, during the turbulent years of the Cultural Revolution. While we are in no position to assess the correctness of these reports, I can report what happened to several friends whom I had known in the United States many years ago and who returned to China. One, a plant physiologist who had worked exclusively in the laboratory, felt that his enforced sojourn in a commune—where he had to build his own shelter and work in the fields—gave him a much better appreciation of the problems faced by farmers and made him more cognizant of the kinds of things he should be doing to improve the lot of his agricultural colleagues. Together with workers on the commune, he devised a technique for the economical production of crude gibberellins from waste agricultural products on the commune. This has made possible, it was reported to me, a 20 percent increase in the yield of barley on test plots. Both the scientists and workers seem completely convinced of the efficacy of their practices. Whatever discomfort the Western-trained plant physiologist may have suffered was more than compensated for by his new contact with practically trained farmers, and his collaboration with them yielded important new procedures. This is one example of "bringing science to the people."

Another is that of an American-trained pediatrician, the wife of a former colleague, who had practiced in a New Haven hospital. Upon her return to Peking in the mid-1950s, she set up practice as a pediatrician in Peking and felt that she was doing all that she should for her people. But when the Cultural Revolution started about 1965, Chairman Mao pointed out that while 80 percent of the Chinese people lived in the countryside, almost all of the physicians lived in the cities. She responded by asking her family whether they would mind her joining a medical brigade going to the countryside. Since her children were fairly grown and could spare her, the family gave permission. For eighteen months she was out in the countryside with the medical brigade, setting up health centers in villages, carrying out mass inoculations, training paramedical personnel, and giving instructions to a wide variety of medical technicians. She returned from this experience feeling that she had never before been so useful as a physician. It is true, she said, that while in the countryside she had suffered some discomfort because of the difficulties of life there. She was, after all, city born and bred, and had lived in the relative comfort of Peking. Subjecting herself to the arduous conditions of primitive villages in the backwoods areas of China had posed some difficulties, but after the experience was over she felt happy that she had volunteered.

It is believed by many in the West that some professors and scholars were executed, and that many who were either exiled or forced to do manual labor during the Cultural Revolution have not been restored to their past positions. From all that we could come to understand this is not true. Some professors who could not adjust to new conditions were retired prematurely. Some had to "go back to the people" to be "re-educated," but in no instance, we were told, had the Cultural Revolution led to executions or permanent loss of the

technical or cultural resources of the people working at universities. This conclusion was affirmed also by Dr. C. N. Yang, the Nobel physicist of Stony Brook, New York, who was in Peking in mid-1971 to visit his father, a professor emeritus at National Tsinghua University.

The university today is an extension of the political and cultural philosophy of the Chinese Revolution, and especially of the Cultural Revolution of 1965 to 1969. It will produce a group of people, based in the working classes of China, subjected to a briefer, more practical, and more intense learning experience.

How, it may be asked, can true education proceed in the absence of freedom of inquiry? We do not know to what extent the Chinese are hampered by restraints on their freedom of thought and expression. Clearly it is not possible to oppose Chairman Mao's line, but neither is it true that Chairman Mao has been built up as a symbol in the same way that Joseph Stalin was in the Soviet Union. The cult of Maoism, according to many, including Premier Chou En-lai, was a manifestation of the excesses of the far left wing of the revolutionary factions during the early days of the Cultural Revolution. Many observers feel that there is now a progressive de-emphasis on Maoism. His statues, posters carrying his sayings, and buttons bearing his picture are disappearing rapidly from China. But certainly there are some things the Chinese cannot read and other things they cannot write or speak about, at least at present. This will certainly hinder them if the practice is prolonged.

It is at least possible that with the emergence of a stronger, more confident, more secure People's Republic of China, the restraints on the intelligentsia will be lifted and freedom of expression and contact with the rest of the world will become enlarged. This is perhaps a hopeful and optimistic view; I offer it as a foreseeable possibility. It is a possibility at least as likely as opinions to the contrary that have been vouchsafed by China watchers who have not been to the People's Republic of China, and who continue to deduce everything they know from partial news releases and small slits in the bamboo curtain. ■

You Are What They Ate

Were our primordial ancestors aggressive meat eaters or supervegetarian freaks?

People who are into the health food and vegetarian movement like to say, "You are what you eat." When my son, a 16-year-old "fish-etarian" (no red meat, but plenty of canned tuna) asks me if food affects the nature of the soul, I usually try to change the subject. Recently, however, I've had to admit that the idea is food for thought. In an evolutionary sense, organisms do owe their nature to their diet.

Our species—*Homo sapiens*—shows its true nature by what it eats. Some human populations are exclusively meat eaters, some exclusively vegetarians, and others eat everything from raw meat to excrement (as in clam cocktails). Thus, the species as a whole is neither carnivorous, herbivorous, nor omnivorous. We are just immensely variable. Our dietary indefiniteness implies that man's nature is to be able to learn to be carnivorous, herbivorous, or omnivorous in conformity with customs and traditions, or culture. This culture is man's primary mode of evolutionary adaptation.

Many people are dissatisfied with the ambiguity and open-endedness of this conclusion. They try to discover the "real" basis of human nature by reconstructing the primordial diet of man. The erroneous assumption behind this approach is that we are what our ancestors ate.

Judged in terms of book sales, the most successful reconstruction of man's primordial eating habits has been pieced together by playwright Robert Ardrey. He says our ancestors were meat eaters; we are the children of carnivorous apes. "Man is a predator whose natural instinct is to kill with a weapon."

Recent studies of human origins challenge the view that Adam sinned by eating apples in a primeval forest; early man apparently evolved in a plains and savanna habitat. And the possibility that Adam first sinned by eating steak now seems even more remote.

One problem with Ardrey's theory is time. The date of the known ancestry of his "killer apes," the australopithecines, has now been pushed back from 1.5 to 5.5 million years ago. In addition, the known ancestry of the hominids—all man-like creatures—has been pushed back another 10 million years. Paleontologists agree that the separation of the ancestors of the modern great apes and the ancestors of modern man occurred during the Miocene epoch. The earliest of the hominids and the putative ancestor of both the australopithecines and modern man was a small animal called *Ramapithecus*, whose fossil jaws and teeth have been found in East Africa, India, and China. This adds up to nearly 15 million years of distinctive hominid evolutionary adaptations. Hunting could have been an important mode of subsistence for our ancestors during only a small fraction of this vast time span, perhaps only during the last 750,000 years.

The best way to find out how and what an animal eats is to look in its mouth. The jaws and teeth of *Ramapithecus* and *Australopithecus* tell the same story: small incisors relative to molars; reduced canine teeth; large, high-crowned, multicusped molars, which erupt at long intervals; and jaw joints that permit chewing with a rotary crushing, milling, and grinding motion. Everything about this pattern points away from meat eating and toward a vegetarian specialty.

Mammals that consume quantities of fresh raw meat tend to have large canine teeth for ripping open tough hides; enlarged premolars, shaped like long narrow blades, for shearing and cutting; and small, narrow molars. For example, the inspection of a convenient cat (in the unlikely event that you can get it to open its mouth) will reveal only one small molar in each quadrant of the jaw. Nothing could be more ill-suited to the needs of a killer ape than the set of twelve massive, high-crowned blunt "grinders" possessed by the australopithecines and, to a lesser degree, by modern man.

Some authorities, in an attempt to deny the vegetarian implications of australopithecine molar patterns, have postulated the existence of two widely different australopithecines: a small, carnivorous, hunting species and a larger, vegetarian, hunted species, distinguished respectively by small and large molar teeth. Physical anthropologist Milford H. Wolpoff has recently shown, however, that *proportionate to body size*, the grinding areas of the premolars and molars of the small australopithecines is larger than that of the robust forms. If the molar grinding area of the australopithecines is compared with the grinding surface available to the strictly vegetarian gorilla, you have to conclude that our ancestors must have been supervegetarian freaks. According to Wolpoff, the smallest australopithecines had grinding areas similar in size to the gorilla, even though their body mass was only one-quarter to one-eighth gorilla size.

In certain important respects, the basic hominid dental pattern is more like an elephant's than a cat's or a dog's. An elephant's molars are massive, transverse-ridged millstones that can crush and grind grass, roots, branches, and other fibrous and woody substances. Only one elephant molar at a time is functional per quadrant, but as each wears down it is supplemented from the rear by a new tooth.

The long span during which hominid molars continue to erupt (from six to nineteen years of age) is analogous to the elephant. For millions of years, especially prior to the invention of fire and cooking, these molars were subject to heavy abrasive action and hence had to be supplemented from front to rear as their surfaces became smooth and suffered a loss in milling and grinding efficiency. Almost all adult australopithecine fossil molars exhibit

signs of abrasive wear, with a decreasing severity from front to rear.

Worn down, flat molars are also characteristic of the earliest fossil representative of our genus (*Homo erectus*), who evolved out of the australopithecines about 750,000 years ago. Even contemporary primitive populations that cook their grains and vegetables tend to have worn-down molar teeth due to the amount of grit in their foods. The teeth of the australopithecines tell us that our ancestors spent a great deal of their lifetime chewing low-energy foods in order to feed their bodies.

In the killer ape version of hominid origins, the australopithecines were drawn to the open woodlands and savannas by the great herds of grazing animals. Lacking natural hunting weapons, such as claws or tusklike canine teeth, the australopithecines could only become hunters by learning how to manufacture hunting weapons. Upright posture then arose as an accommodation to the need for carrying these weapons from place to place. The version concludes with natural selection acting in favor of hunting skills and killer instincts.

Our teeth will not let this story pass. If the primary adaptive mode of the australopithecines was aggressive hunting with weapons, how can we explain the supervegetarian grinders that linger on for five million years?

Clifford Jolly of New York University has suggested a more plausible reason for leaving the forest. Based on his observation of the way baboons make use of the food resources of modern African savannas and plains, Jolly believes that our ancestors were subject to natural selection, not for hunting instincts, but for their ability to pick up, dig up, grind up, and digest large quantities of low-energy grass seeds, roots, and other tidbits that were available in the savanna and plains. My own guess is that their first tools were probably not weapons but simply sharpened sticks for getting at roots that could not otherwise be dug up.

The early australopithecines, like modern baboons, may have occasionally cornered a rabbit or a small antelope, and they may have scavenged large animal carrion. Like chimpanzees they may have occasionally killed and eaten a larger animal in self-defense. But their feeding activity could not have centered on meat. Even the contemporary Bushmen hunters of the Kalahari, equipped with poison-tipped iron arrows, derive two-thirds of their diet from plant foods.

None of the stone artifacts associated with australopithecine fossil sites can be described as hunting weapons. Some splintered and broken animal bones might have served defensively against predators, but there is nothing that justifies the view that medium- or large-size herbivores were being hunted on a regular basis. The stone chopping tools that go back about 2.5 million years could have been as useful for digging roots and fashioning digging sticks as for cutting animal hides. As weapons of the hunt, they could have had little utility.

The killer ape story is further weakened by indications that the australopithecines spent the majority of their time on earth without any stone tools at all. In surveys of the Turkana region of Kenya, where australopithecine fossils dating back 5.5 million years have been discovered, no trace of any tools has been uncovered. A gap of two million years separates these earliest fossils from the earliest stone artifacts.

It is believed that *Homo erectus* used fire to stampede big game into swamps or over cliffs. But this happened long after the australopithecines had disappeared. There is no indication that the australopithecines ever mastered the use of fire. The weapons—projectile points, spear throwers, bows and arrows—that our ancestors needed to be effective hunters were probably not invented until the last 100,000 to 50,000 years of the 15 million years of hominid existence.

Why then, despite so much evidence to the contrary, has the belief in man's bloodthirsty apehood gained such wide popular appeal? I think the answer must be that the myth of the killer ape places the burden for achieving a more humane world on nature rather than culture. It is a convenient way to avoid responsibility for not living up to the human promise of our most apelike ancestors.

What Do We Learn at the Zoo?

"Despite excellent intentions, even the best zoos may be creating animal stereotypes that are not only incorrect but that actually work against the interests of wildlife preservation"

What did you learn at the zoo today,
Dear little boy of mine?
I learned that an elephant likes the shade
I learned that a tiger paces his cage
I learned that monkeys imitate people
And do funny things to one another
That's what I learned at the zoo today,
That's what I learned at the zoo.

Admission statistics make it clear that zoos are increasingly becoming children's areas. Most adults are accompanied by children, but even the lone adult cannot avoid the chattering presence of children in family groups or in school classes.

Many zoos today stress their role in public education, but this has not always been the case. The earliest zoos, such as the *paradeisos* in ancient Persia, were developed for the amusement of royalty. Later on, the zoo became largely a place of amusement for the general public, and sometimes a place for the serious study of animals by scientists and artists.

While some primatologists have been concerned about some of the lessons people have learned by watching monkeys in zoos, the public education role of the zoo has not received much systematic inquiry. The list of behaviors common in the zoo, but relatively uncommon in nature, includes sexual aberrations, a heavy incidence of aggression, and the blahness common to many animals that don't have anything to do in a concrete cage. Although this had led animal biologists to question the research function of the zoo, it has rarely led to significant questions about the zoo's role in public education.

From the descriptive brochures, one receives the impression that the mere presence of the animals in enclosures is regarded as educational. I think there is good reason to question the validity of this assumption. Are we trying to teach visitors that a lion can survive in a 15 by 25 foot cage or that two animals of a threatened species can occasionally breed in captivity? The sight of animals waiting for visitors to bring them peanuts would seem to develop a homocentric environmental ethic.

One of the most depressing aspects of a visit to a zoo is the amount of petty sadism and exhibitionism displayed by the visitors, adults as well as children. These unfortunate but all too common occurrences make it evident that, by itself, the sight of caged animals does not engender respect for animals.

Prior to the development of photography and inexpensive pictorial reproductions, there was some justification for exhibiting animals as an educational exercise. The zoo provided an opportunity for the public to see what certain animals looked like. However, the ready availability of wildlife documentaries that

show animals in their natural habitats, together with the availability of illustrated nature books and magazines, compels us to view the problem in a new light.

A school teacher or wildlife biologist must ask himself, specifically, whether he would prefer the public to observe a species in the zoo or see a good documentary film. The question need not be framed in an either/or manner. It may be that in a large specialized zoo, with an adequate staff and budget, certain species can be adequately portrayed in their natural habitats. Yet other species, such as large mammals, simply cannot be accommodated in any kind of urban zoo without doing gross violence to their natural behaviors.

Certainly it is an achievement to keep some species alive in captivity, and the scientific community will readily applaud such efforts, particularly if the animals are able to breed successfully. I would encourage such experimentation particularly when the species is endangered in its own habitat. These efforts, however, fall in the category of research, rather than public education. This is not merely semantic quibbling, for there are important policy differences between research and education.

During the last few years there has been a critical examination of the ethnic stereotypes we have lived with for so long. Occasionally, as with the portrayal of the American Indian, the issue comes directly to the door of the natural history museum with its displays of the early American West. The use of ethnic stereotypes in advertising (Little Black Sambo, Aunt Jemima, the Frito Bandito, the Kachina whiskey bottle) has provoked cries of outrage from people who feel that their identities are being misrepresented.

However, we cannot expect a similar organized movement among captive animals whose exhibition does an injustice to their natural behaviors. This task must fall to members of the human species who care about wildlife. The perpetuation of stereotypes about the dangers from wolves and hawks has already been recognized. It seems time to turn a critical eye at the lessons taught by the modern zoo. Despite excellent intentions, even the best zoos may be creating animal stereotypes that

are not only incorrect but that actually work against the interests of wildlife preservation.

I became interested in this issue in a roundabout way. For many years I have taught abnormal psychology to university students. At one time or another, students have requested field trips to nearby mental institutions. Initially this seemed like a good idea, so I arranged for such trips. However, since I believe in evaluating all such programs, I later asked the students what they had learned.

I was terribly disappointed at the results. The students had seen what was there, but from my standpoint and that of the hospital staff, they had drawn the wrong lessons. To explain this I have to say something about the patient population in most mental hospitals. At any given moment, the vast majority of patients can be described as "psychiatric failures." When a new patient is admitted to the hospital, he is placed in an admission ward, and in all likelihood, he is discharged from there in less than three months. However, if he does not respond to treatment, he is transferred to a chronic ward. Although this may be a small percentage of the new patients each year, the accumulation of chronic patients makes up perhaps 90 percent of the hospital population at any given time.

Imagine what happens when a class of young and impressionable college students visits an institution of this sort. First of all, a visit simply cannot be restricted to the admission wards. The students want to see where "the violent ones" (a virtually nonexistent species) are kept, and if you refuse to show them what the chronic wards are like, they believe that something is being hidden from them.

The only reasonable solution is to open the entire hospital to the visitors and let them go wherever they want. This means that the students will observe a vast number of middle-aged and elderly men and women sitting around corridors and dayrooms looking disconsolate and detached.

If you ask the students what the hospital needs most, they reply that it needs more buildings, since the wards are obviously overcrowded.

Continued on page 84

The New Archeology of China

"Let the past serve the present"

Mao Tse-tung

by Judith M. Treistman

In the summer of 1968, a unit of the People's Liberation Army, operating in Hopeh Province in northern China, came upon a tomb cut deeply into the rock of a mountain. Great stone blocks over which molten iron had been poured sealed the mouth of the tomb. The soldiers and their commander, together with local peasants, blasted through the iron wall.

Inside lay the remains of Liu Sheng, ninth son of Emperor Ching Ti of the Western Han dynasty (206 B.C.–A.D. 24). The prince, who died shortly before the first century B.C., and Tu Wan, his wife, interred in a nearby tomb, were encased in garments of jade, each made of more than 2,000 small rectangles of the fine stone, pierced at the corners and joined with gold wire. It was believed that such costumes would preserve their bodies.

Carefully, under the guidance of archeologists, the soldiers and peasants excavated the tombs and sorted about 3,000 funerary artifacts: bronze and gold vessels, ornaments of gold, silver, and jade, ceramics and lacquerware, silks and splendid chariots, all the appointments and insignia of royalty and the life of the aristocracy. At the head of each body was a pillow sculptured of jade; and, in waiting on the princess, a kneeling servant cast in bronze and gilded, holding a lamp with a movable shutter. In the prince's tomb, the workers found a bronze incense burner, or censer, fashioned to represent Mount Po, a remembrance of carefree days spent hunting there. Clouds of gold and silver were inlaid on the carved peaks, and the forms of wild animals seem to play amid the jagged cliffs. When incense was lit, the smoke would emerge from numerous perforations to swirl around the mountain heights.

The picture of soldiers and peasants of the People's Republic digging in the dust of the past, revealing the ostentatious wealth and magnificence of former royalty, may seem incongruous, but, in fact, such activities are very much a part of the Cultural Revolution. Threads of continuity are there, raised to ideology in Mao's thought, "Let the past serve the present." The lesson of history, according to Mao Tsetung, lies in the evidence of class exploitation, of the oppression of the peasants by the gentry. Conceived of in this way, the laborers of two thousand years ago—who removed 64,000 square feet of solid rock—are linked sympathetically with the men and women of the People's Revolution. There exists,

A funerary object from the tomb of Tu Wan, this lamp of gilded bronze was cast in the shape of a palace serving girl, who herself holds a detachable lamp. It was an ingenious device: the light could be directed to either the left or the right and the amount of light controlled by adjusting the opening.

too, the open admiration expressed by today's craftsmen for the skill and talents of yesterday's artisans, a feeling common to the experience of archeologists all over the world.

A revolution in archeology occurred in the wake of China's political revolution of 1949. Many of us continue to think of the pursuit of archeology as a luxury. We savor exotic civilizations much as we enjoy fine wines, fulfilling our dreams of romance, exploration, and discovery. But in China, as in many other countries undergoing a redefinition of nationhood, archeology has become a necessity.

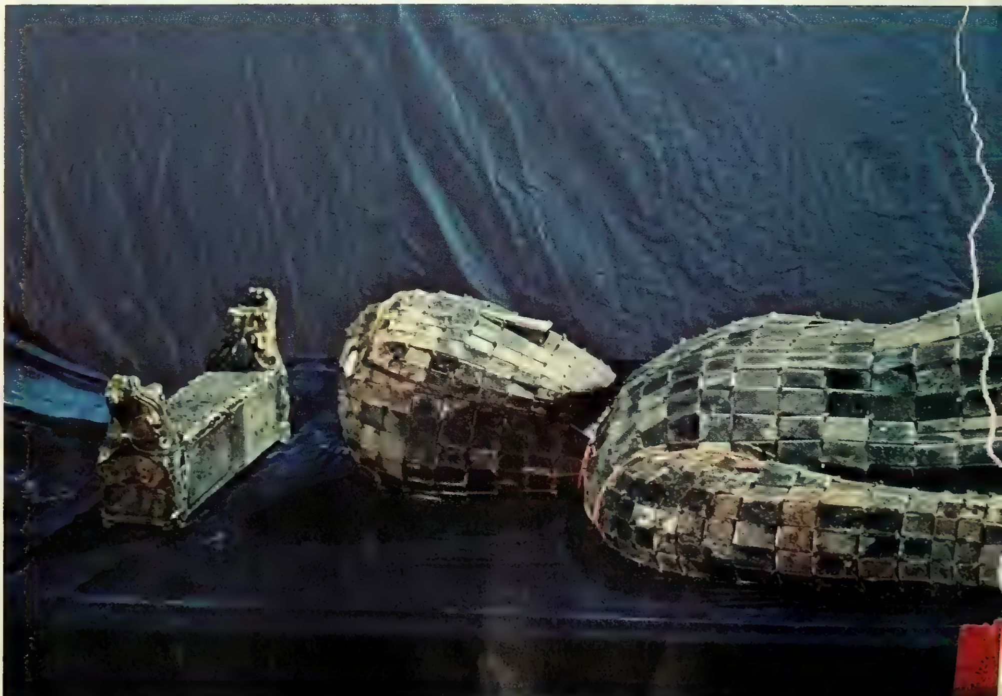
The new archeology, which developed so quickly after the establishment of the People's Republic, first began in the 1920s and 1930s when intellectuals were questioning the classical tradition of historiography, challenging the uncritical acceptance of earlier documents. It was the archeologists who attempted to meet the demands of these young scientific historians, and they were highly successful. Perhaps the best known of the discoveries during this time was the site of Anyang, the royal city of Shang, a civilization of the second millennium B.C. previously known only from fragmentary inscriptions and the work of scholars writing for Chou dynasty kings in the following millennium.

Throughout the first half of the twentieth century, however, Chinese archeology was plagued by unscrupulous persons who scoured the markets for antiquities to be sold at fabulous prices to art collectors all over the world. Tombs were looted, frescoes torn out of walls, and statuary dismembered, shipped abroad, and reassembled in museums and private gardens.

The new Chinese archeologists of the 1950s inherited a chaos out of which they strove to make some order. As part of their plan, they established provincial and district museums and "institutes" of archeology. These served a dual purpose: the training of local field workers and the prevention of further malpractices through popular education aimed at encouraging pride in the history and crafts of the nation. Several hundred sites were put under government protection as cultural monuments, and at least one prehistoric site, an excavated Neolithic village, was preserved as a permanent museum.

Early in the revolutionary phase of Chinese archeology, the attempt to "make order out of chaos" fostered a theoretical reduction of all historic processes into a simplified Marxian framework, a series of social stages beginning with primitive society and climbing through slavery and feudalism to the present. While this formal scheme is still retained, the most recent work is focused on a more critical appraisal of the interplay between socioeconomic relations and history, as well as on the esthetic appreciation of artifacts.

Because the Chinese are bent on



discovering themselves, and are not concerned with exotic peoples from other parts of the world, their archeology has little of the anthropological cast to which we are accustomed. Chinese scholars do not engage in comparative studies; they do not seek "universals" of human behavior that cross cut societal and cultural boundaries. Culture change is explained in terms of historical conditions, with ecological relationships receiving little attention.

The few Westerners who, in the years preceding the 1950s, concerned themselves with the study of Far Eastern antiquities painted a rather bare picture of China's past. The record included a population of almost-human Peking men in northern China about half a million years ago; scattered Neolithic sites known almost exclusively from pottery remains, which were frequently interpreted as evidence of cultural diffusion from the West; and bronzes and oracle bones with inscriptions attributed to the time of the Shang dynasty. The arts of metallurgy and writing were supposed to have derived from Western inspiration, and the terms used to describe China in the twentieth century—unchanging, backward, and unoriginal—were often applied to her past as well. Building on a foundation of scientific excavation (this was introduced by Western geologists and paleontologists), the work of the past twenty years has completely overturned these ideas and has so filled the archeological map that the prehistory of China now emerges as dynamic, innovative, and vastly complex.

The re-excavation in 1959 of the caves of Choukoutien (see *Natural History*, November, 1971) has swelled the fossil *Homo erectus* population of the north; even earlier *H. erectus* had apparently inhabited an area in the Shensi Province of central China. Discoveries in southern China of *H. sapiens neanderthalensis* (Kwangtung and Hupeh) and "primitive" *H. sapiens sapiens*

The jade death suit of Liu Sheng, restored to its original splendor, conveys the extravagance of royalty during the Han dynasty.

(Szechwan and Kwangsi) have considerably broadened our knowledge of early man in eastern Asia during the Pleistocene. The signs of human activity during nearly a million years of shifting climates and environments come archeologically in the form of differentiated physical populations and specialized tool industries. It is no longer possible to cast all fossil men in the image of Peking man. The discovery of bifacial hand axes, flake tools, and a microblade tradition suggests that, confronted with the specific problems of his environment, early man in China followed specific paths for survival.

In the first decade after 1949, several thousand sites of agricultural villages were found, and many hundreds of trial excavations have been reported. Apparently, as indicated by the great diversity of style preferences in pottery types and designs of the period, regional affiliations were being formed during the fourth and third millennia B.C. These developments may signify the beginnings of circulating markets and trade of craft products.

One early village, excavated in its entirety between 1954 and 1957, is at a site called Pan P'o ts'un, near the city of Sian in Shensi Province. It was a large settlement of about 17 acres, divided into a central living area, a cemetery, and a series of pottery kilns outside the drainage ditch that surrounded the village. At any given time, this village may have had some two hundred households, with a population of five or six hundred persons. The houses were built of the most readily available materials: mud, straw, and hewn logs. They were low ceilinged and had southern entrances to protect them from the cold northerly winds. Some of the dwellings were small and round in shape, with inner partitions between eating and sleeping areas; others were larger, rectangular buildings, which may have sheltered bigger families. In the center of the village stood a roofed structure of more than 1,700 square feet, with a high, fired-mud foundation wall in which the roof supports were anchored. We can imagine that important community activities took place in this building.

From pollen analyses done at the site, we know that millet was the major agricultural crop, but remains of chestnuts, hazelnuts, and pine seeds remind us that gathering wild foodstuffs was an important activity. The high frequency of plants that are now considered weeds, notably chenopods, suggests that these were intensively collected or possibly even cultivated. The people of Pan P'o ts'un hunted small game, and from numerous artifacts and bone remains, it seems that nearly everyone in the village must have engaged in fishing. A fish motif was used exuberantly in the beautiful painted pottery that was produced here.

It is difficult to select only a few of the many discoveries from this long and immensely exciting period of early farming, but perhaps we should pause a moment to look at Kansu Province in western China. People here, living in small villages scattered along the river terraces, cultivated millet and vegetables. These crops alone were insufficient to sustain the population, however, and were supplemented by a wide range of small game. Because the region is marked by rugged hills, ravines, and gullies, generations of families were isolated for long periods and a complex succession of art styles developed.

Recent archeological studies have attempted to unravel the chronology of these cultural phases. Many new examples of the beautiful Pan Shan urns that were formerly exported in great numbers to collectors in Europe and the United States have been excavated. The Pan Shan style appears as a unifying force that seems to have broken through the endlessly repetitive pattern of village life. Perhaps it embodied the death ritual, itself a reaffirmation of universality; per-

Silk shoes with cloud-shaped toecaps are among the many colorful Tang dynasty artifacts that have been preserved by the arid climate in the Turfan Basin of Sinkiang Uighur.

This vivid silk fabric of the Tang dynasty, recently unearthed with other well-preserved silks and linens in the Turfan Basin, provides evidence that, through the ages, China carried on active trade and cultural exchange with western Asia and Europe.

haps the famous modeled lids of the urns hint at the drama of the ritual.

Last year an exhibit of ancient artifacts recovered since the beginning of the Cultural Revolution opened in Peking. The objects on display were selected from literally thousands; it is said that in Shensi Province alone, more than 160,000 pieces were discovered from 1966 to 1970. The reports of these discoveries seem to reflect the current tendency of Chinese archeologists to emphasize the early historic periods that gave definition and shape to the Chinese way of life. Interest in the earlier, prehistoric periods seems to have waned, perhaps because the purpose of establishing the great length of human occupation in China has been served or perhaps because of a lack of interest in the broadly generalized cultures of Paleolithic and early Neolithic times.

The recent discovery of a nobleman's tomb (Chou dynasty, 1100–221 B.C.) in which eighteen individuals, all wearing iron collars, were buried with a man of wealth substantiates the presence of a slave class in early Chinese society. Of somewhat later date (the Western Han period), is a set of glazed pottery figurines, probably a burial gift, unearthed in Chinan, Shantung Province. In this marvelously preserved vignette of court life, the separation of classes is clearly seen. Acrobats, dancers, and musicians entertain the nobility; the orchestra has drums, pipes, and ringing musical chimes. A set of 25 such stone chimes, incised with phoenixes and gaily painted, has recently been found in Hupeh Province, where they were used sometime between 475 and 221 B.C.

A common misconception is that the history of ancient China is an orderly succession of dynasties, each rising to dominance and falling to its defeat; each in turn having controlled a far-flung empire. Thus we name entire epochs after a particular reigning dynasty of a certain area, and mistakenly apply that name to all of China at a given time. This impression of political unity and smooth periodization of centralized power stems from our tendency to focus on the official histories written for the kings of the northern states, such as Chou and Han.

One effect of recent archeological research has been the redirection of our attention to the more than one hundred states, large and small, that existed in various regions of ancient China, reminding us that, then as now, China's population is made up of many different ethnic groups. Our whole concept of the East during the last few centuries that preceded Christ has been considerably broadened as many centers of ancient culture have been discovered throughout all parts of China.

Archeology is gradually revealing the presence of several centers of metal-using civilizations in southwest China. These sites are especially interesting since they represent cultures only vaguely described by the Chinese historians of the north. They may be related to the Bronze Age cultures in North Vietnam and Thailand. At Tap'ona, near Tali in Yunnan Province, a unique cemetery was excavated in 1964. One pit tomb contained a wooden chamber plastered with lime on the outside. Inside this chamber was a bronze coffin cast in the shape of a pile house with a gabled roof. The complex coffin was made of seven pieces, each decorated with either geometric designs or representations of wild animals and birds. A bronze kettledrum was found in the cemetery, along with bells and the fragments of hundreds of other bronze implements.

Another cemetery excavated near Lake Tien in Yunnan during the 1960s has proved to be one of the most spectacular archeological sites in China. This site was used for a long time, spanning periods comparable to the Chou and early Han dynasties in the north. The essence of the civilization is best captured in the bronzes, which transfix the details of everyday life: market scenes, battle scenes, and rituals are all portrayed in sculptured bronze

vessels and in the engravings. Dancers and musicians come alive, and people are shown engaged in their occupations: plowing and sowing grain, harvesting, hunting, and weaving. Lines of boats with strangely dressed oarsmen steer the spirits of the dead through the netherworld.

Two new trends have emerged in Chinese archeology since the Cultural Revolution. One is the location and excavation of the early cities, in an effort to explore in depth the nature of city planning and the socioeconomic relations of developing urbanization. The second, also in keeping with the explicit goal of writing economic history, is the piecing together of the history of technology.

Two examples of this kind of urban research can be briefly mentioned to indicate the scope of these investigations. In the region of Hsin T'ien, Shansi Province, two walled cities of the Chou period have been excavated. In both, walls enclosed an inner area where tiled wooden buildings stood on raised platforms. These secluded buildings were reached by ramps running up from the streets. Ruts worn by the traffic of two-wheeled carriages can still be seen. The entire area may have been further enclosed by a moat, serving to separate the dwellings of the wealthy inhabitants of this inner city from the working people who

lived in and around the clusters of workshops. These workshops are found in little surrounding villages that specialized in particular craft production: ceramics, chariot fittings, bone tools, coinage. In all, the complex of small settlements that tied into the center stretched over more than 18 miles.

In the Loyang region of western Honan Province, two major cities were built, one during the fifth century and the other toward the end of the third century, B.C. The earlier and larger city had walls enclosing an area of nearly 2,000 acres, although not all of this space was occupied at the same time. Here, again, the city was divided so that the quarters and workshops of the workers were separated from the homes of the rich, a class differentiation that extended to the cemeteries as well. In the burying grounds of the poor, the dead were placed in small, rectangular graves,

An insight into the court life of the Western Han dynasty is provided by this set of acrobats and dancers entertaining nobility. The glazed pottery figurines were recently unearthed in Chinan, Shantung Province.

accompanied by simple offerings of glass and bone jewelry, bronze and iron utensils, and grain and meat in pottery containers. The lacquered coffins of the wealthy were interred in underground rooms lined with wooden walls painted to simulate hanging carpets and screens. Pottery and bronze figurines were also placed here as "retainers" intended to serve the dead for eternity.

One of the important results of technological studies has been a much clearer understanding of bronze production. Although the beautiful bronze vessels of the Shang and Chou periods have long been admired all over the world, for many years the techniques of manufacture were misunderstood. It was assumed that the finely detailed designs could be achieved only by the lost-wax process (cire-perdu) familiar to the West; indeed, this was considered a major point in the diffusionist argument that Chinese civilization derived from ancient Mesopotamia. It was also claimed that the Shang bronzes found at Anyang were the product of a fully developed industry that had no indigenous antecedents. Excavations of the bronze workshops, however, have revealed first, that a somewhat more primitive bronze metallurgy did indeed exist prior to the move of the Shang to Anyang, and second, that the bronzes at Anyang were made by the complex piece-mold process.

Outside the city walls of ancient Ao, near modern-day Sian, the earliest foundries yet known in China were excavated. The floors of these foundries were littered with slag (the remains of once molten copper), broken clay crucibles and pouring beakers, and thousands of fragments of earthenware molds and clay cores used to cast the simple implements of everyday use: knives, arrowheads, and fishhooks.

Discovered in Hunan Province, this bronze jar dates to the Shang dynasty (sixteenth to eleventh centuries B.C.). The lid was made at a later time.

Arrowheads were made in simple two-part molds. These consisted of slabs of baked clay in which a half-dozen shapes were hollowed out and connected to a central channel. Molten metal was poured into the tightly bound molds, and after cooling, the arrowheads were cut off at the central stem. This process was further developed by making a fired clay model, which could be sculptured and engraved with designs, and then making a clay mold of the model. These multipieced molds were used in the casting of intricate metal objects.

Another aspect of recent research resembles what Americans call "historical archeology," excavating done with the purpose of obtaining cultural information not usually included in traditional historical documents. In 1968, an excavation involving this kind of approach was done at the site of one of the two vast granaries that operated at Loyang about A.D. 600. During the Sui dynasty, millions of people were impressed, under threat of decapitation, into a great laboring army. At the expense of hundreds of thousands of lives, they built an incredible system of canals, uniting the rich agricultural regions of southern China with the north. Grain, collected as taxes, was shipped from all over the country to Loyang along the Grand Canal. The granary itself occupied an area of 4½ million square feet and contained more than 400 silos, each 20 to 60 feet in diameter and as deep as 33 feet. Some of these silos still contained grain when they were excavated.

Finally, I should mention the numerous recent discoveries that attest to the active contacts between China and the rest of the world in early historic times. Sassanid, Byzantine, and Japanese coins of gold and silver remind us of the far-flung trade that took place in the sixth, seventh, and eighth centuries. At the time that cities such as Changan were becoming great cosmopolitan centers—drawing merchants from India, Southeast Asia, Japan, Korea, Persia, and the western Mediterranean—the Chinese were also struggling to maintain control of outposts along the Great Silk Road, which skirted the oases of the western deserts. An extremely dry climate accounts for the remarkable preservation of silks and linens found in the outer region, now known as the Sinkiang Uighur, through which they exported to the west.

Some of the silks found in tombs along the Silk Road are almost 2,000 years old, but they still retain the bright colors of their lively patterns. The weavers of ancient China knew many techniques, which they skillfully manipulated to create extremely complex designs. Silks had previously been found in archeological excavations of Shang tombs at Anyang. These early pieces were in both plain weave and twilled, but the newly discovered fabrics, which are dated somewhat later, include tapestries, gauzes, damasks, and embroideries.

An interesting technological development came when the Chinese workshops of the Tang period (A.D. 618–907) began to produce silks in the Sassanian style of Persia. Patterns were executed in the weft of the fabric rather than being determined by the arrangement of warp threads. Sassanian motifs also became popular, and are found along with more traditional Han designs.

Another technique of treating silk appeared after the Han period; this involved creating designs on the woven fabric by tie-dyeing and resist-dyeing, or batik. These methods may have been introduced from Southeast Asia. A recently discovered Tang silk gauze was decorated by a complex resist-dyeing process using more than one color. The figures in this design depict a hunting scene: mounted riders are shown chasing hares and deer among trees and flowers.

The extensive trade and cultural relations that existed in the past between China and the West stand in contrast to the isolation that exists today. When this isolation is finally ended, when scientific and scholarly exchanges are resumed and examination of the artifacts of the past encouraged, archeology will be enriched by a better understanding and appreciation of China's history and culture.

Bison Would Rather Breed than Fight

Because too much fighting can leave bison bulls too weak to survive the winter, they have found other ways to settle disputes

by Dale F. Lott

The sky really *is* bigger in Montana—a colossal, inverted bowl of vivid blue. In late July and early August, plumes of dust, rising with earth-warmed air from the brown grass and rolling rangeland, ascend into that bowl. The dust makers, a herd of bison on the National Bison Range, are going about their business—breeding—and I am going about mine—observing, recording, and trying to understand their behavior.

Most of the dust comes from wallows, shallow pits where the bison have torn away the sod with their horns and where the subsoil, dried by the sun and stirred by hoofs and horns, turns to a flourlike dust. Some of the plumes start when threatening bulls paw and roll in these wallows, but most occur when fighting bulls plow the soil with their hoofs, or when they slam their heads together and the shock explodes dust from their bodies.

A fight between two bulls is an awesome sight. They slam their foreheads together with short straight lunges or drive the tips of their short, curved horns into each other's foreheads with sideways hooking motions powered by their tremendous necks. Chunks of hair twice as large as a man's fist are sliced from their foreheads and float in the air above them. The bulls circle each other swiftly. Occasionally a bull will charge into an exposed shoulder or flank and, with the tips of his horns, drive an opponent forward, but this is rare; usually it is the head that both delivers and receives the blows.

To survive these fights, the bulls are protected in several ways. Their short, heavy, curved horns catch and parry hooks and charges, and their strong necks absorb some of the force of impact. The way the hair grows on their heads also helps. By the time a bull is six years old, a mat of hair several inches thick extends from the top of his head down across his forehead, thinning gradually until it stops just above his muzzle. His eyes peer from shallow wells, his ears flick out from deep recesses, and the space between his horns is completely filled with this luxuriant growth. Beneath this natural shock absorber a thick layer of tough hide covers his forehead.

The effectiveness of this combination was demonstrated to me one afternoon when I saw a rare event in buffalo combat: a full gallop charge by one bull at another. The attacked bull took the charge squarely on his forehead. Although he skidded backward about two body lengths, he stayed on his feet, counterattacked, and soon triumphed.

So natural selection has produced an animal that can withstand the charge of a 2,000-pound battering ram with horns. But tough as he is, a bison bull is not invulnerable. Some are injured every breeding season, and occasionally one is killed. Since all his protection is concentrated at his head, the usual point of attack, a bison bull is easily wounded by a horn thrust from the side. This is generally true of horned or antlered animals. If they are facing an attack, they can usually protect themselves. But to face it, they must be able to anticipate or predict it: they need information.

The signal that one animal is about to attack another is one of several kinds of information that individuals in most species must exchange. Discovering what information is exchanged, and how and why it is exchanged, is an essential early step in understanding the social system of a species and its role in adapting the species to its habitat. My studies on bison began with this problem and focused primarily on aggressive behavior. The information used to predict attack was one of the first things I studied.

Territoriality provides this information for some species. The territory owner usually attacks all competitors within a given space and keeps up the attack until they leave. All that is needed to predict attack fairly successfully is a knowledge of territorial boundaries.

But bison, like many other animals, are not territorial. They are roamers, drifting singly or in small, temporary groups across their range. Because they cannot use their location in space to predict whether or not another animal will attack them, they depend on sig-

nals. When we speak of signals between humans, we usually mean a communication in which the communicator intends to send a message. But all that is necessary for communication is that one individual be able to detect and respond to some change that consistently precedes a particular behavior in another individual. Behavior that consistently precedes an attack, and to which other animals respond appropriately, is called a threat.

It is clearly to the advantage of an animal about to be attacked to become canny in judging his enemy's behavior. Generally the task is made easier by the enemy who, instead of disguising the coming attack, often amplifies those characteristic behaviors, draws attention to them, and in every way makes it easy to see what he is about to do. If forewarned is forearmed, why not attack first and give indication later? The reason, of course, is that it may not be necessary to attack at all. Forewarned is often foredefeated. This result occurs at least often enough to make the warning worthwhile.

A fight avoided is also risk and energy expenditure avoided. As my knowledge of the bison has increased, I have come to see that fighting is an occasionally necessary grand spectacle, but the real biological drama lies in the complex, drawn out, and frequently subtle ways in which most conflicts are settled by communication. Let me describe some of that drama to you.

The breeding season is the only time during the year that mature bulls and cows are together for any length of time. The bulls, which have been alone or in small, temporary groups, join the cows, which have been living in larger groups with the calves and young bulls. The bulls seek out certain cows, usually those in estrus. They stay with these cows if they can (this behavior is called "tending"), keeping other bulls away by threatening and fighting.

But threatening and fighting are also common between bulls that are not defending cows. Since receptive cows are the only scarce resource in the bulls' economy, this seems surprising at first: one wonders what the non-tending bulls are fighting about. But it does make sense because an animal dominated now will probably give way later in the breeding season without a contest, saving a tending bull time and effort when he has none to spare. Not that the bull works it all out like this. He simply has a powerful urge to dominate other bulls, and following this impulse works to his advantage. This drive to dominate is so powerful that it occasionally interferes with his real business and its ultimate function. Bulls will sometimes leave a receptive cow to threaten a distant bull.

The threat that operates at the greatest distance is vocalization. On a still day the bellow, or roar, of a bull carries several miles. If you can't see the bull or don't recognize the sound, you're likely to think that a thunderstorm is brewing.

If the competition presses, the bellowing becomes louder, and a quality that is hard to define but somehow easy to recognize—a quality of fury—begins to grow in it. Often one or both bulls will interrupt their bellowing to paw the ground or wallow.

If the challenge does not end in the wallowing or bellowing stage, the bulls draw closer to each other and special postures come into play. There seem to be two distinct threat postures. In the "head-on threat," which is simply the posture and movement that precedes a charge, the bull moves toward his opponent with his head held slightly to one side. The more slowly the challengers are moving, the farther to the side their heads are held. When they approach nearly straight-on, either one bull submits by turning away or they bang heads. But when they approach slowly with their heads well to one side, they often stop close to, but not quite touching, each other and enter into a pattern I have named "nod-threat."

Nod-threatening bulls stand close enough to reach one another; their bodies may form a single, straight line or an angle of up to ninety degrees, but in either case their heads are held well to one side. From this position they can attack suddenly by hooking a horn into the opponent's head. The hook always starts when the head is close to the ground, the muzzle tucked back toward the feet.

But in the threat, the head-low, muzzle-back position is only a brief interruption of a head-high stance: the bulls' heads drop in a matched movement, then swing back up again, still to one side. A hooking attack may start at the bottom of any one of the down swings, but the opponent never seems to be caught off guard. After a series of such nods one animal may suddenly submit, ending the clash.

Nod-threatening takes place most often between bulls that are not tending cows. In this respect, it resembles another important threat, the "broadside threat." A bull in this posture keeps himself broadside to his opponent with his head held a little higher than normal. Usually his back is arched and he is bellowing. If he moves, he does so slowly, in short, stiff steps that keep him broadside to his opponent. Often two bulls will threaten by standing parallel to each other with only a few feet separating them. Only rarely does this threat lead to a fight. The encounter may be long as threats go, as much as a minute or more, but one of the animals almost always submits.

The broadside threat and the nod threat emphasize the degree to which the bulls forewarn their opponents. This forewarning is so elaborate that it has become a force in its own right. It goes beyond permitting the prediction of attack; by substituting for attack, it often overpowers the opponent.

This may account for some puzzling aspects of these postures. Why, for example, do the bulls threaten by turning broadside? When turned this way, a bull seems very vulnerable to attack, particularly if the bull he is threatening is facing him. (This danger by the way, is more apparent than real. In watching thousands of such threats I have seen only one broadside bull attacked.) Perhaps the function of the broadside threat is to display the full size and power of the bull, as well as to forewarn the opponent. If the threatening bull makes a big enough impression he may save himself a fight.

Bison stir up dust in wallows worn into the sod. When worked into the animals' coats, the dust inhibits the activity of insect pests.

The one recurrent note in all these descriptions of fighting and threatening is that they go on until one animal submits. Submission signals serve two functions: they enable a bull to withdraw from an encounter without getting into a fight, and they enable a bull that is losing a fight to end it without injury and without retreating a long way. There are two questions to ask about the communication of submission in bison: How do they signal it? Why do the winners accept it?

All bison submission signals are variations on a theme; the submitting bull turns away. Sometimes it is a 180-degree turn followed by a galloping retreat. Other times it is an abbreviated swing of the head and neck to one side. When it involves a 90-degree turn, the submitting animal ends up in the same general position as one who is threatening broadside. It is easy to tell the difference, however. In submission the bull's head is usually low, muzzle extended as if to graze (and sometimes he does graze), and the bull is silent. Whatever form the submission signal takes, it almost always stops the threats or attack immediately.

I recall in dramatic detail one example the bulls gave me of the power of this signal. Two bulls were fighting in a swale below me. The low ground was moist, so the grass was green even in early August. The spurting dust raised by most fights was missing, and the rich contrast between the warm brown of the bulls' coats and the green grass gave the scene a certain tranquillity. But the bulls were fighting in earnest. They slammed their heads together, stepped back a few feet, then drove their foreheads together again so hard that the shock of the impact seemed to ripple through their bodies in a wave. There were three or four such blows, and then, just as they had drawn back and were poising to plunge together again, one of the bulls simply stood in his tracks and swung his head 90 degrees to the right. The winner had already started his forward lunge. His front feet plowed sudden dark furrows in the green grass as he skidded to a stop. His horns could not have been more than 18 inches from the loser's neck. The two animals stood immobile for a few seconds; then both walked quietly away.

Fights usually stop just that abruptly and with the loser just that vulnerable. One more step, one more lunge by the winner, and the loser would be out. But that step is almost never taken.

This describes the way submission is signalled, but there is still the second question: Why does submission work? One is tempted to explain it by analogy to human institutions, to say that bison operate by a set of "rules"; that the loser is kept from harm by the winner's conforming to rules, just as a football player who has been knocked off his feet is protected from further assault by the rules of football. But this kind of analogy, between social behavior and social convention, obscures rather than clarifies.

The rules of football are a social invention based on enlightened self-interest and reciprocity. Players agree to be restrained from some destructive acts, provided the oppo-

Two mature bulls engage in nod threats, swinging their heads up and down in matched movements. Their heads are up most of the time; an attack comes only when they are down.

sition is similarly restrained. Kicking an opponent in the head when he is down is so dangerous, everyone agrees that it should be penalized by giving the other team some advantage in play. This penalty imposed by a specialized group of rule enforcers is the mechanism through which rules control the football players' behavior.

There are, however, no reciprocal agreements and no rule enforcers among bison. Each bull's behavior meets his own needs and no other bull's. The only penalties for any action are those assessed by the action itself. At first thought this seems wrong. How would a winning bull penalize himself by polishing off a loser? The fact is, he would be assessed two precious commodities: time and energy.

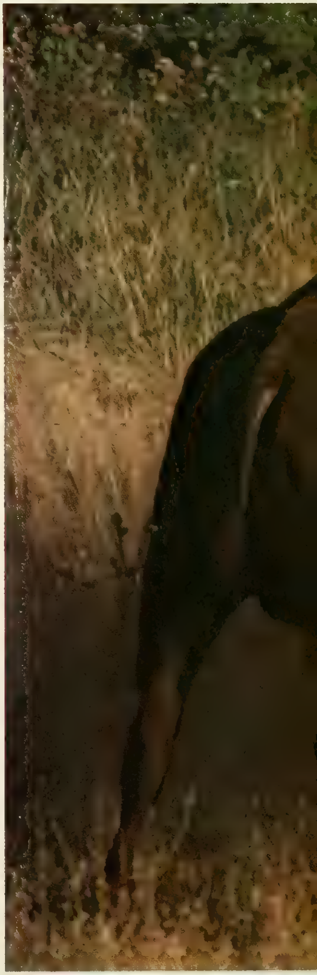
Time is valuable because most conflicts take place in the breeding season, and time spent fighting, even a mop-up operation, is time lost from breeding. Besides, if winners did not stop attacking when losers submitted, losers would give up less readily, and fights would be more time consuming.

Fights to the finish would take even more energy, and that is in shorter supply than you might imagine. When you see bulls in the middle of the summer, in the midst of tall grass and warm sunshine, their good health and nutrition seem assured. But bison are northern animals, one of the most northern of the cattle family. They have adapted to a climate where food is scarce through long winter months, where the males of other hoofed species, deer for example, frequently die during the winter because fall caught them without enough stored energy in the form of body fat.

Breeding season takes a lot of energy as it is. The mature male loses an average of 200 pounds between June and October. If every fight was long and rough and ended in a wild cross-country chase, bison bulls, winners and losers alike, might well die before spring renewed the plains.

Pursuing and destroying the loser would eliminate the need ever to face him again, of course, but that would accomplish little. Bison breed in large groups, with the males moving constantly from one group to another. There are always many more challengers where the last came from. In the final analysis, the winner does not spare his defeated rivals, he spares himself.

The prolonged forewarnings, the reluctance to fight, the generosity to losers are neither the last noble vestige of chivalry in our time nor nature's way of exhorting man to live on a higher ethical plane. Rather, they are carefully balanced behavioral adjustments to the social and ecological circumstances in which the competition between bulls evolved. They are among the basic ecological adaptations that enabled this animal to thrive so mightily that little more than a hundred years ago, 50 to 70 million bison dominated the plains of North America, shaping the grasslands where they walked and shaking the earth when they stampeded.



The bull on the right threatens, while the bull at left submits by swinging his head to the left and down until his beard nearly touches the ground.

Heads low, eyes open, two bulls ram into each other after a short charge. Each tries to hook the other with a horn, but a fatal wound is rarely inflicted.

Conception and Contraception

The delicate human reproductive system can be upset by emotional stress, by many chemical compounds, or by an assortment of devices

by Gerald Oster

Reproduction is not essential for the existence of an individual, but it *is* crucial for the survival of a species. However, if the population increases at too high a rate, the species may be threatened. This now seems to be the case for man.

Under social conditions of maximum fertility, a woman in her reproductive years (typically between the ages of 15 and 50) can produce twenty children. To have fewer progeny requires some form of birth control. One method, which is sanctioned by the Catholic church, is the rhythm method. It is of doubtful effectiveness, however, because it requires abstinence from sexual intercourse during the week in each menstrual cycle when a woman is supposedly at the peak of her fertility. Another method, known as coitus interruptus, or withdrawal, is the traditional birth control method of Roman Catholic couples in many European countries.

The most commonly used contraceptive device, the condom, also prevents venereal infection, which was said to be its original function when it was invented in the sixteenth century. Another effective device for barring the passage of sperm is the diaphragm. Perhaps because it requires individual fitting and because of the care with which it must be inserted into the vagina, the diaphragm is not popular worldwide. Other sperm barriers include vaginal foams and jellies.

Of increasing interest is the intrauterine device, or IUD. The modern IUD is a plastic object, which is aseptically inserted into the uterus by a trained person (most easily for women who have already had a child). The IUD is a highly effective method of birth control, and if no complications occur, the device can remain unattended indefinitely. Unfortunately, clinical experience over the past few years has shown that perhaps one-third of the users do suffer complications (particularly excessive bleeding and backache), which are relieved when the device is removed. Sometimes the device is spontaneously expelled by the uterus.

Of much greater popularity, particularly in the United States and many Western European countries, is the Pill, or oral contraceptive. It was introduced in the mid-1950s by the late Gregory Pincus of the Worcester Foundation in Shrewsbury, Massachusetts. In an experiment conducted at a Puerto Rican housing project, Pincus, in collaboration with John Rock and Celso Garcia, demonstrated that a woman could control her reproductive functions via an oral route. The Pill is now one of the most extensively used medications; some 30 million women throughout the world take it daily.

Despite its proved effectiveness, the Pill is not widely used in the developing countries, except among the more educated women of the cities. It is most popular among women who are sufficiently motivated to take it on a strict regimen. When a medicine is so extensively used, especially one that drastically alters the hormonal balance of the body, complications inevitably arise. To give one example, the Pill suppresses lactation. As a result, in underdeveloped countries where mothers' milk is the principal nutrient for children up to the age of three, some governments are refusing to promote the Pill for the populace as a whole.

Some of the Pill's side effects are minor, but others, notably thromboembolism, reported by British and American clinicians, can be fatal. In certain medical quarters, there is the gnawing feeling that long-term use of the Pill carries the possibility of carcinogenetic action, which would become apparent only by the mid-1970s. Doctors have already decided against administering the Pill to women susceptible to breast cancer, such as the highly inbred Parsi women of Bombay.

Abortion, or as it is called in more timid circles, the termination of pregnancy, has long been an effective means of birth control. In Hungary, where abortions are legal and performed free of charge, the number of abortions actually exceeds the number of live births.

Actually, spontaneous abortions occur frequently, many without a woman even sensing it. Such fetal wastage may occur in 15 percent of conceptions. If abortion is taken to mean any process that interrupts the development of the fertilized ovum, then the IUD is probably an abortifacient, as is, in the opinion of some experts, the Pill.

The progress of birth control is

greatly impeded by the huge gaps in our knowledge of human reproductive physiology. Much of our information is derived from the study of animals, but unlike the circulatory system, the reproductive system varies widely from species to species. At the present time more is known of the reproductive functioning of the sow, for example, than of women.

All animals except humans exhibit obvious characteristics, known as estrus, during the time of ovulation. The female will accept the male for intercourse only during estrus, signaled to the male by various visual, auditory, and olfactory clues. The female of our species, on the other hand, will in principle accept the male at any time, and both she and her mate do not seem to be conscious that ovulation might be occurring. Our nearest relatives, the higher apes, show distinct signs when ovulation is approaching. When the female chimpanzee ovulates and has maximum interest in the male, the skin at her vulva reddens and enlarges greatly. Recently, it was found that at ovulation the chimpanzee produces in its vagina a substance, appropriately named copulin, that fills a male chimpanzee with intense sexual ardor. This is one of the many olfactants present throughout the animal kingdom that serve to attract animals to their mates.

At ovulation, some animals, including the dog, show a vaginal discharge containing blood. This was long confused with menstruation. Aristotle thought that the human fetus was a consequence of the mixing of semen with menstrual blood. Not until the early 1930s, when K. Ogino and H. Knaus clarified the situation and promulgated the rhythm method, was it generally understood that the most fertile period of a woman lies somewhere at mid-cycle, between successive menstruations.

Primates (excepting the New World monkeys) are unique in the animal kingdom in that they exhibit a monthly shedding of the uterine lining, or endometrium, which contains non-clotting blood. The bleeding for humans, typically about one-half cup per month, is far more copious than for other primates. Although the average, but variable, period for women is 28 days, which happens to coincide with the lunar month, menstruation has nothing to do with the phases of the moon. For chimpanzees the average period is 35 days.

Human ovulation usually occurs about two weeks prior to the onset of the menstrual period. But the preovulatory period varies considerably, depending on a variety of factors. The menstrual cycle can be interrupted by sudden changes in habits. Stress factors play a role and clearly demonstrate the involvement of the central nervous system in reproductive physiology. A study of women in mental institutions demonstrated that irregular cycles were caused by emotional, rather than nutritional, factors. This disruption is a kind of unconscious regulation of fertility, a process that exists throughout the animal kingdom and acts as a safety valve on the population in times of extremely bad environmental conditions, such as a shortage of food. A recent study of college women in dormitories found a tendency toward synchrony in menstrual cycles among friends and roommates, thus suggesting a social factor in human reproductive physiology.

Because of the implications for population growth, demographers are concerned by the results of an English study that indicate that the average age for the onset of menstruation, menarche, has dropped from 17 a century ago to the present average of 13. This appears to be a worldwide trend and might be related to the increase in the quality of nutrition. Menarche usually takes place after the appearance of such secondary sex characteristics as the budding of breasts, the deposition of fat on the hips, and the growth of hair in the armpits and in the pubic region. The girl is usually infertile until her ovaries are functionally mature, and regular cycles set in. The ovaries no longer function at menopause, the time when menstruation ceases. Medical records indicate that over the past century the average age of menopause has gradually increased to 50 years.

The details of the menstrual process were observed in the remarkable experiments of the late J. E. Markee of Duke University. Working with a monkey, Markee introduced a piece of the endometrium into the anterior chamber of the monkey's eye. With a low-power microscope, he observed the histological changes during the menstrual cycle.

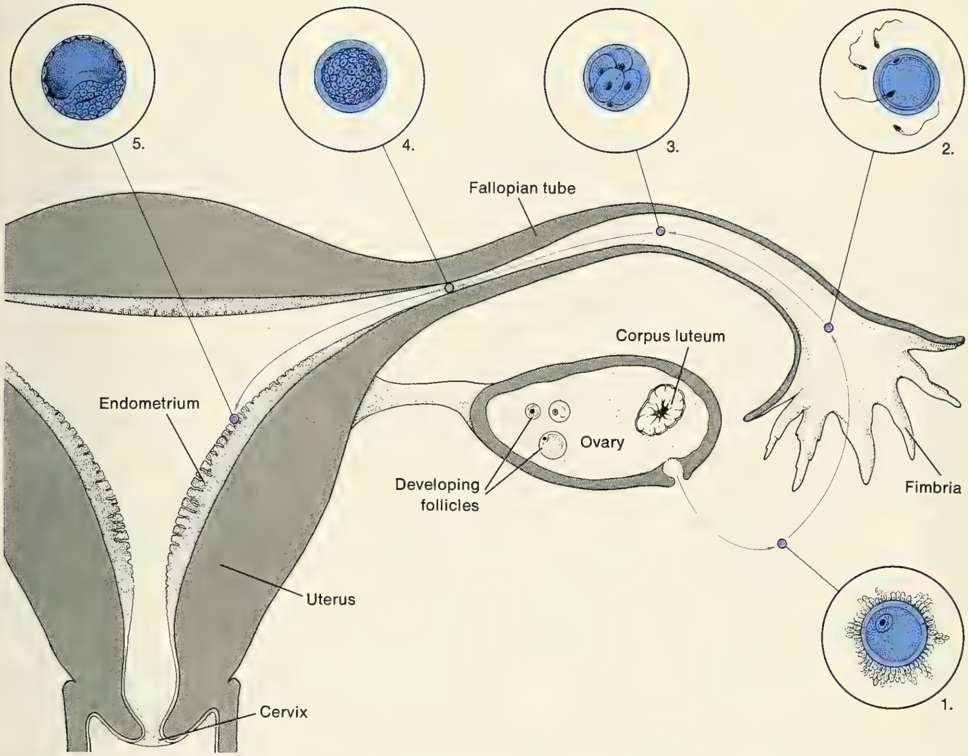
Just before menstruation, the tissue blanched because the blood flow was shut off by contraction of the peculiar spiral arteries of the endometrium. This was followed by a bursting of the vessels, the hemorrhage of menstruation.

When menstruation is complete, typically after five days, the number of cells in the tissue increases rapidly, repairing the damage of menstruation in about two days. For the subsequent week up to ovulation, cells proliferate in the endometrium, increasing in thickness by about five times. For the next two weeks, until menstruation, the endometrium becomes increasingly convoluted and tortuous. The tissue becomes spongy and the cells secrete.

This cycle in the endometrium is a preparation of the uterus for a fertilized ovum. The function of the uterus is to house the developing embryo until it is mature enough to be born and survive on its own. If the endometrium does not receive the fertilized ovum about one week after ovulation, it breaks down in menstruation.

The physiological need for menstruation is unclear. What C.W. Corner wrote 30 years ago in his classic, *The Hormones in Human Reproduction,* applies today: "Menstruation, then, is still a paradox and a puzzle—a normal function that displays itself by destruction of tissues: a phenomenon, seemingly useless and even retrogressive, that exists only in the higher animals; an unexplained turmoil in the otherwise serenely coordinated process of uterine function." Certainly, menstruation is not a detoxification process, as was once commonly thought, due, perhaps, to the constant references to it in chapter 15 of Leviticus as being "unclean."

In the reproductive system, the



ovaries influence the endometrium in several ways. After the follicle develops into an egg in the ovary, it passes through the ovary wall and down the Fallopian tube. If the egg is fertilized, it may become implanted in the endometrium. The ovaries produce estrogen hormones, which encourage the repair and development of the endometrium. In addition, a temporary organ, the corpus luteum, develops in the ovary immediately after an egg is released. The corpus luteum produces another hormone, progesterone, which further prepares the uterus for implantation of the fertilized ovum. If implantation takes place, the estrogens and progesterone then act in concert to maintain the implant. If implantation does not take place, the concentration of the hormones suddenly drops drastically and menstruation follows.

The estrogens are biosynthesized (from cholesterol) in the growing follicle. The endometrium grows at the same time that the follicle develops. Estrogens are circulated in the bloodstream and reach their peak in concentration at ovulation, about the fourteenth day in the cycle, with another surge about a week later.

The output of progesterone by the corpus luteum reaches a peak about ten days after ovulation. If pregnancy does not occur, the corpus luteum degenerates to form a connective tissue scar.

In humans, the corpus luteum functions for about the first two months of pregnancy, after which its hormonal activities are taken over by the placenta, and the gland degenerates. To survive for the two months, the corpus luteum depends on hormonal production by the placenta. This production is induced by a glycoprotein (a protein containing carbohydrate) known as hu-

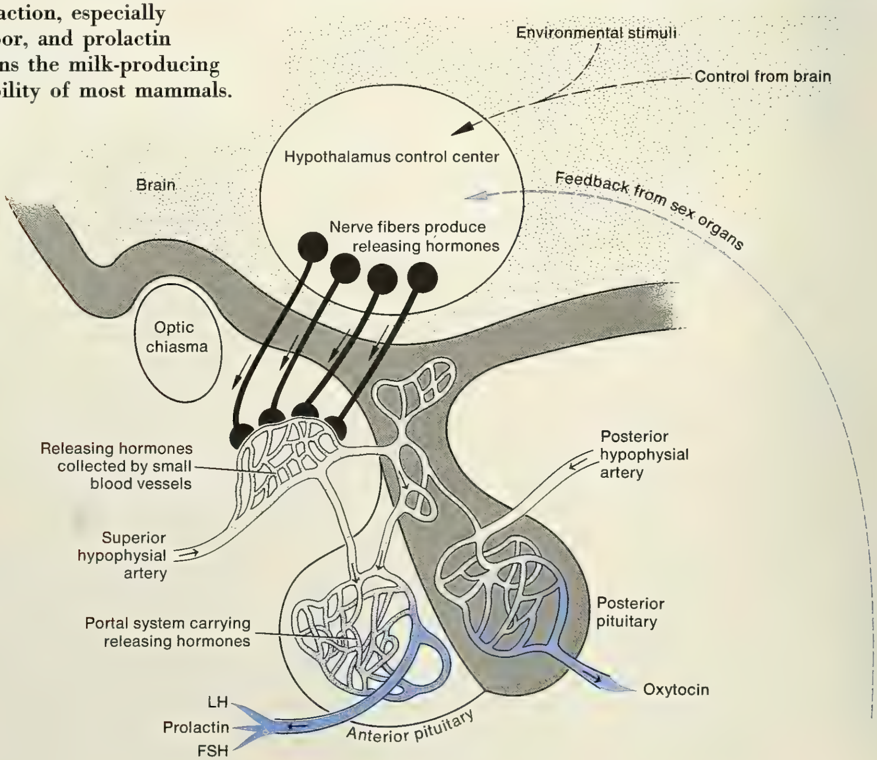
The egg discharged from an ovary on day 14 (*1*) awaits the arrival of sperm (*2*), which has passed up the Fallopian tube via the cervix and the uterus. The egg's actual size is about one-hundredth of an inch. The fertilized egg undergoes several cleavages without changing its size (*3* and *4*) and passes down the Fallopian tube. The blastocyst (*5*) is implanted in the uterine wall. The whole process, from ovulation to implantation, takes about one week.

man chorionic gonadotrophic hormone. Since this substance will produce a red inflammation in the ovaries of an immature rat, it provided the basis for the once-common pregnancy urine test invented by M. Aschheim and B. Zondek in 1928. Whereas the test in its original form took five days, the present test, involving an immunological precipitation, is carried out in the doctor's office while the patient waits, usually anxiously. Recently, a do-it-yourself kit based on the same principle has been developed.

The gonadotrophic glycoprotein hormones and at least six other hormones are produced in the pituitary gland. This pea-sized gland is an appendage of the hypothalamus, which lies at the base of the brain. It has long been known that the removal of the pituitary from mature female animals results in atrophy of the ovaries and, eventually, the rest of the genital tract. If the gland is grafted back to its original location, the sexual cycle of the animal is restored. And if extracts from the anterior (but not the posterior) portion of the gland are injected in an animal, sexual functioning is restored. Two of the hormones produced by the anterior pituitary gland, the follicle-stimulating hormone (FSH) and the luteinizing hormone (LH), are most immediately related to reproduction.

FSH stimulates the growth and maturation of follicles in the ovaries. LH, in conjunction with FSH, promotes the maturation of a single follicle. Why one follicle is chosen at the expense of the others, and indeed, how one oocyte out of some half-million initially present in the ovaries is destined to become the ripened egg, is as yet a complete mystery. Following maturation of the follicle, LH causes ovulation by inducing a rupture of the follicular wall with release of the egg. In humans LH also stimulates the corpus luteum to release pro-

Production of gonadotrophic hormones in the pituitary is controlled by signals from the brain and by the feedback action of estrogens and progesterone from the sex organs. Nerve fibers carry messages that signal the release of hormones in the pituitary. In humans, LH and FSH govern the menstrual cycle. Oxytocin influences uterine contraction, especially at labor, and prolactin governs the milk-producing capability of most mammals.



gesterone. In a normal menstrual cycle the LH concentration in the blood exhibits a sharp maximum somewhere around the time of ovulation.

FSH will induce ovulation in some infertile women. But in half the successful applications of this treatment, there has been an embarrassment of riches and multiple pregnancies (as many as seven) have resulted. One source of an FSH-like substance is the urine of postmenopausal women whose ovaries have ceased to function despite the efforts of the pituitary to reverse this. A commercial enterprise in Rome obtains this substance from urine collected daily in a tank truck from nearby convents. Some Swedish gynecologists working on infertility prefer pure FSH prepared from human anterior pituitaries (obtained from cadavers).

The hypothalamus controls the release of FSH and LH from the anterior pituitary. The hypothalamus, to which the pituitary is attached, lies at the base of the brain and serves as a decoder for messages from the central nervous system. The hypothalamus and the anterior pituitary have no neural connections, but they share a blood system that is somewhat isolated from the general circulatory system. On receiving signals from the central nervous system, specific polypeptides, which are releasing factors for LH and FSH, are generated in the hypothalamus. They flow via the blood system into the pituitary and cause the gland to release the gonadotrophins. One recent approach to fertility control proposes immunization against the polypeptide releasing factors. This would involve the injection of these laboratory-produced substances to build up immunity to them.

The hypothalamus also governs sexual maturation in humans, as has been deduced from pathological conditions. For example, tumor of the hypothalamus, which is very rare, can cause a normal-sized child of eight to become sexually mature. The record for such a case is that of a child of five who, after menstruating since she was one year old, gave birth (by Caesarean section). It may be significant that girls who are blind from birth often exhibit an unusually early menarche.

In addition to triggering changes in the sex organs, the estrogens and progesterone exert controls on the flow of LH and FSH from the pituitary. Through feedback mechanisms, the hypothalamus, which is the control center of the reproductive system, will signal for an increase or decrease in LH and FSH, depending on the concentrations of estrogens and progesterone it detects in the blood. For example, estrogens in low concentration stimulate the production of LH, while at high concentrations they inhibit its production. Presumably this type of seesaw action causes the 28-day menstrual cycle.

The effectiveness of many types of the Pill is apparently due to the influence of the estrogens and progestin on the hypothalamus, with a resultant suppression of ovulation. There are some thirty preparations of oral contraceptives on the market. They consist of synthetic steroids, modified estrogens and progestins, and for each commercial product the chemical structure may differ, as does the estrogen—progestin ratio.

The estrogen and progestin combination in the Pill apparently works synergistically; that is, the mixture is more effective than the sum of its components. Two types of pills have been developed. One consists of a combination of an estrogen and a progestin and is taken from day 5 to day 25 of the menstrual cycle in order to establish an artificial 28-day cycle. The other, the sequential pill, consists of an estrogen to be taken for 10 to 15 days, followed by a combination of an estrogen and a progestin for 10 to 15 days. This latter regimen requires a smaller total quantity of progestin.

One of the major directions in the field of birth control is to find a substance that, taken orally only once a month, would cause the uterus to become an unfavorable environment for implantation of the fertilized egg, but would otherwise not interfere with a woman's normal physiology.

Progestin by itself is a contraceptive. One observation is that under its influence, the peristaltic action of the ovarian ducts is altered so that the fertilized egg arrives in the uterus too soon for implantation. In the absence of estrogens, however, progestin may cause spontaneous bleeding.

On the other hand, the estrogen component of the Pill causes most of the numerous undesirable side effects. Some fatal, but fortunately, rare cases of pulmonary embolism have been directly traceable to the estrogen component. Since estrogen causes water retention, the most common complaint of women taking the pill is a bloated feeling. Nausea, similar to the "morning sickness" of early pregnancy, is another frequent side effect, caused when the estrogen stimulates the contraction of the gastrointestinal tract muscles.

Particularly annoying for many women on the Pill is the appearance of facial blotches, the so-called mask of pregnancy, after exposure to the sun. This may be a consequence of the estrogen-induced high copper levels in the blood, which catalyze the oxidation of skin pigments. Another complaint is that the Pill produces migraine headaches, which disappear if the sufferer stops taking the Pill.

Protagonists of the Pill argue that these side effects are essentially eliminated with the correct choice of type, which should take account of the woman's medical history and be followed by periodic checkups by a gynecologist. Unfortunately, such highly trained personnel are not available for many women, especially in the underdeveloped countries, and the future of the Pill as a major deterrent to the world population explosion is an open question.

Because the Pill interferes with the whole reproductive system—and other systems of the body as well—considerable birth control research has focused on other techniques. Some of these approaches are, in effect, attempts to modernize the condom, to stop the movement of sperm to the egg. The special properties of the mucus of the cervix make it a good subject for birth control studies.

This mucus, secreted from a

number of glands in the cervix, is most copious at mid-cycle. Its physiochemical properties are such that the sperm will move readily through it at mid-cycle but not at other times. The cervix serves as a valve for the passage of sperm; it is closed except about the time of ovulation. The vagina of women in their reproductive years is usually strongly acid, due to the bacterial production of lactic acid. At mid-cycle, however, the cervical mucus exhibits a maximum in alkalinity. This provides a favorable gradient for sperm motion because sperm move more rapidly in alkaline than in acid media. In addition, mid-cycle mucus has peculiar flow properties not shown by postovulatory mucus. The ability of mid-cycle cervical mucus to be drawn into a long, fine thread provides a gynecologist with a convenient indication that a woman is ovulating.

Why the cervical mucus is most threadlike at ovulation is a question we are trying to answer in our laboratory at the Mount Sinai School of Medicine. The mucin component of cervical mucus interacts with albumin. We are investigating various chemicals, notably substances bearing positive charges, that suppress the transport of sperm into cervical mucus. Polymeric forms of such substances might be active over a period of a few days with a single vaginal application.

Birth control might be simplified if a woman was aware of the time in the cycle when she is fertile. A woman using the rhythm method charts her basal body temperature during the course of a few cycles to determine her ovulatory pattern. A metabolic product of progesterone produces, probably by its action on the temperature control center of the hypothalamus, a rise of about half a degree centigrade, which persists through the postovulatory phase. However, this thermal rise appears *after* ovulation. Even if a "safe" period were established for a few months in a row there is no assurance that this pattern will be followed in a subsequent month. Furthermore, extensive studies have shown that only 25 percent of all women exhibit a clear-cut mid-cycle temperature rise.

One indicator of ovulation is a mid-cycle vaginal discharge, consisting of a small amount of cervical mucus and a trace of blood. This phenomenon is probably an evolutionary remnant of estrus in animals. The discharge, often so slight as to be unnoticed by many women, might be a reliable indicator if a convenient color test for its presence were devised. Some women occasionally experience a sharp lower abdominal pain at mid-cycle (named *Mittelschmerz* by German gynecologists).

The metabolism of vitamin C is also cyclic in women, with a pronounced minimum in vitamin C concentration in the urine at mid-cycle. Estrogen biosynthesis in the ovaries involves the consumption of vitamin C, and this consumption is maximal at mid-cycle. The phenomenon of vitamin depletion could be utilized as an ovulation test if it were first shown that the minimum occurred independently of the vitamin C intake in the diet.

A test that anticipated ovulation by two days or more would be most useful in birth control. In my laboratory we have indications that the concentration of sialic acid in the saliva is at a minimum a few days before mid-cycle. Experiments with artificial insemination of ewes and cows have demonstrated that sperm capable of fertilization remain in the female genital tract for as long as two days. More limited experience with artificial insemination of women at fertility clinics indicates that the two-day period of sperm survival applies to humans as well.

If more were known about the biochemical processes associated with the nurturing of a single follicle in the ovaries, perhaps a practical preovulation test could be developed. With an accurate test, birth control could be practiced by abstaining from intercourse for three days, two days for the lifetime of the sperm and another for the lifetime of the egg.

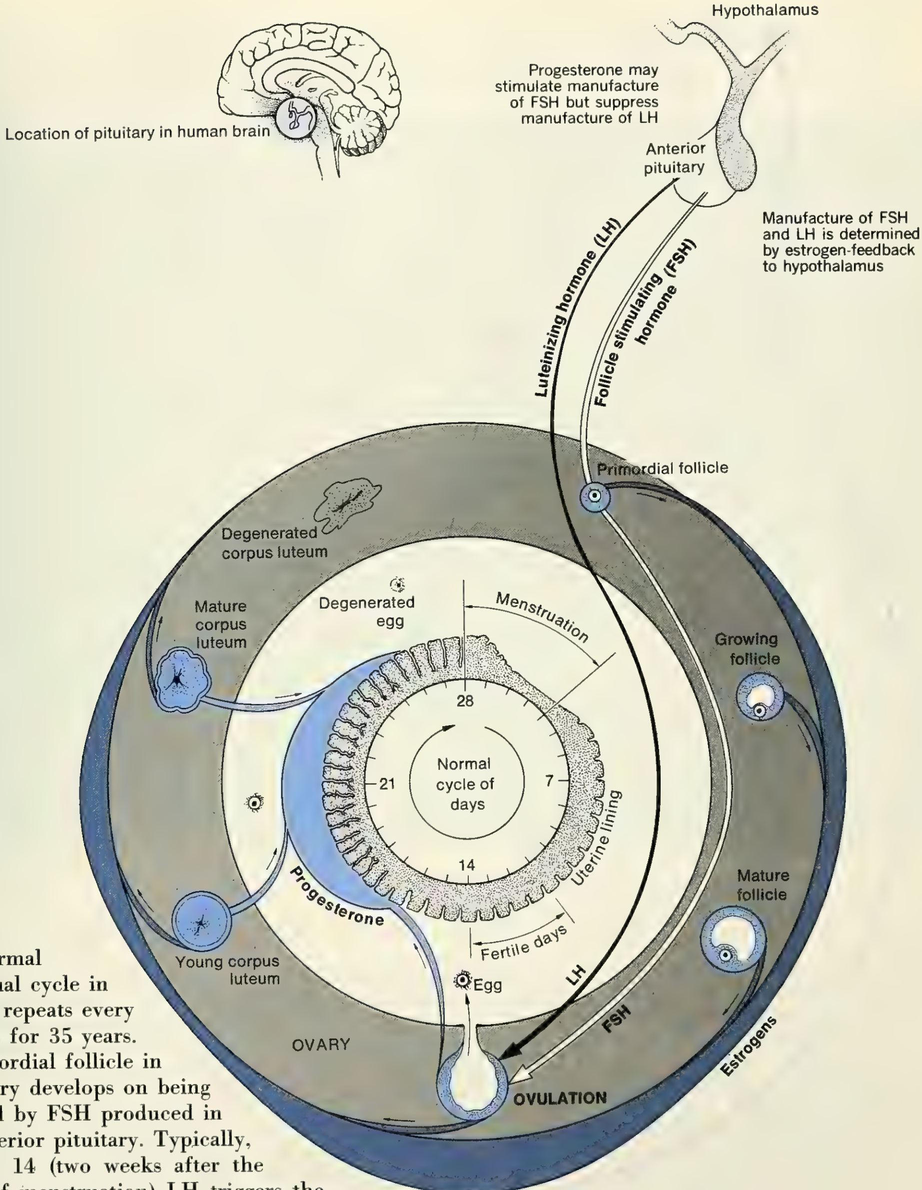
Sperm moves into the female tract very rapidly. Some evidence indicates that sperm are present in the cervix within a minute after intercourse. This demonstrates the futility of using douches following intercourse. Tests on farm animals and a few humans show that sperm reach the site of fertilization within fifteen minutes after intercourse. This is too rapid a movement if only the intrinsic motility of sperm is considered. Indeed, test particles such as carbon granules are propelled along with the same speed. Obviously, the peristaltic movement of the musculature of the female tract is responsible for this rapid sperm movement. Some oral chemical agent might be found to arrest this peristaltic movement, but it would have to be very efficient.

Of the 500 million or so sperm in a single ejaculate, only about one hundred reach the site of fertilization. This tremendous attrition, caused primarily by scavenging white cells, takes place mainly in the cervix. But the motion of the remaining sperm would have to be completely arrested or destroyed if fertilization were to be prevented. Attrition of the sperm is total, however, in the case of certain sterile women whose cervical mucus contains a precipitating factor, possibly an antibody, for sperm.

The transport of the egg is controlled by the beating of cilia as well as by peristaltic action of the tubes. This movement has to be delicately controlled to insure that the egg arrives at the site of fertilization at the most propitious moment, that the fertilized egg develops sufficiently to be acceptable to the uterus, and that the uterus has time to prepare for the implantation. Progestins seem to upset this delicate timing sequence.

Certain cationic detergents such as clomiphine—which for rats, at least, is a powerful antifertility agent—cause a rapid expulsion of the ovum through the tubes. This suggests that such substances might serve as postcoital contraceptives. Large dosages of estrogens arrest the movement of the fertilized ovum. It has long been the practice among dog breeders to feed diethylstilbestrol, a simple phenolic substance having estrogenic properties, to stop pregnancy in bitches who have been accidentally mated. This substance is also effective for humans, where it has been used for cases of rape, but its side effects, in-

Continued on page 76



The normal menstrual cycle in women repeats every 28 days for 35 years. A primordial follicle in the ovary develops on being signaled by FSH produced in the anterior pituitary. Typically, on day 14 (two weeks after the onset of menstruation) LH triggers the release of the egg from the mature follicle. Meantime, the uterus is being prepared for implantation of the blastocyst. If fertilization has not occurred, the uterine lining breaks down and menstruation begins two weeks later. Estrogens are produced in the follicle and peak at about day 14, when development of the uterine lining becomes accelerated. Progesterone is produced in the corpus luteum and peaks at day 21. Estrogens and progesterone feed back to the hypothalamus and control the production of FSH and LH. In this way, the whole process becomes periodic.

X-raying the

The ancient Egyptian kings suffered from bad teeth, arthritis, arteriosclerosis, and possibly polio

No relic of antiquity has been more romanticized or made the subject of more incredible misinformation than the ancient Egyptian mummy. Visitors to the Mummy Room of the Egyptian Museum in Cairo often expect to see mummies as they appeared in the horror films of the 1930s: grotesque figures with fearsome grins, sunken eyes, and bandages just loose enough to reveal a fist clenching nine tanna leaves. Lying in gilded sarcophagi, they waited with sinister patience for the unwelcome intruder to stray too close.

Visitors with such expectations are invariably disappointed. Mummies, with their leatherlike skin and frozen features, look unreal but certainly not frightening, and they lie in simple oak coffins in a stark room that resembles a storeroom more than a repository for ancient royalty. While most of us realize that mummies are not terrifying creatures ready to invoke ancient curses, few are aware that mummies are worthwhile subjects of scholarly research.

Most people believe that because the hieroglyphs of ancient Egypt can be read, its art analyzed, and its buildings excavated, a vividly clear picture of Egyptian life has been reconstructed. Unfortunately, this is not true. Egyptology is a young discipline; hieroglyphs could not be read accurately until well after Jean François Champollion published his decipherment in 1824, and most of the texts from ancient Egypt are still in need of careful translation. Scientific archeology is even younger, and of the thousands of archeological sites known in Egypt, the vast majority are still undug or only partially dug or have been destroyed by thieves and untrained amateurs. In fact, while a historical skeleton of ancient Egypt can be constructed, there is not very much flesh to add to its bones. Papyri, paintings, and texts simply do not tell enough. For the study of three aspects of ancient Egypt—physical anthropology, medicine, and mum-

Pharaohs

by James E. Harris and Kent R. Weeks

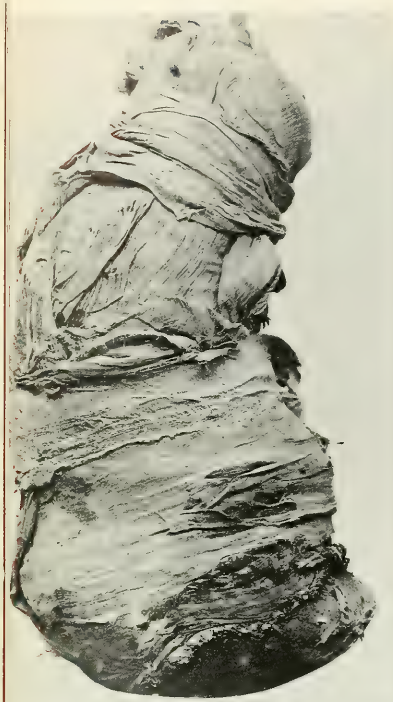
Beneath the carved masks and wrappings lies the mummy of Amenhotep I, an Egyptian king who died more than 3,000 years ago. X-rays, like that at left, gave modern scholars their first view of the body, which had never been unwrapped because of its excellent state of preservation.

mification—ancient mummies can be of immense help.

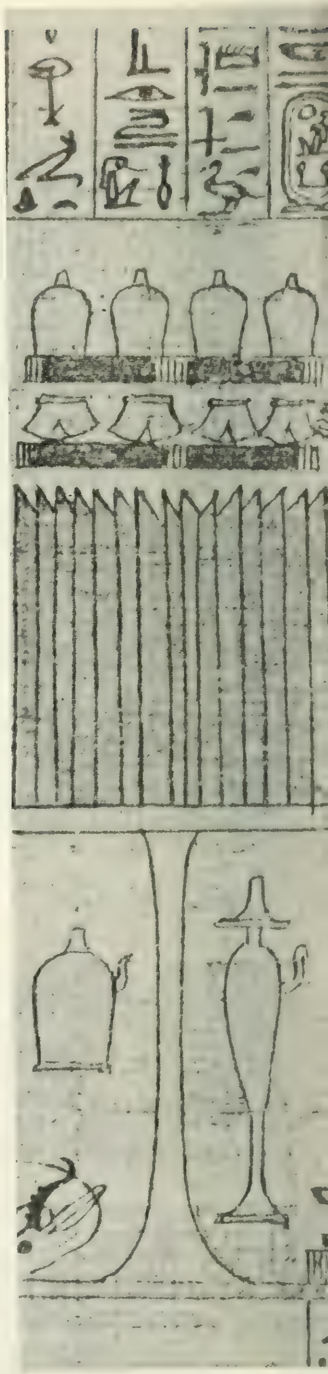
From what diseases did the ancient Egyptians suffer? What surgical techniques did they use? How did diet affect their health? How long did they live? Where did they come from? How did they prepare their dead for burial? The remains of the Egyptians themselves can provide answers that can have a great effect upon the foundation of Egyptological study, the chronological framework upon which all other data are based.

The value of mummies for Egyptological study has been recognized since the late nineteenth century, when two great caches of royal mummies were discovered at Thebes. The problem for nearly eighty years was how to study them without doing damage to the ancient tissues and bones.

Any complete examination of mummified remains requires that the bodies be unwrapped and their internal structures probed and analyzed. In Europe and America, an occasional mummy had been dissected and a full-scale autopsy performed, but no one felt that the royal mummies could be so treated. These mummies formed a unique collection. Many of them were so beautifully wrapped that to destroy their bandages and dissect their organs was unthinkable.



A small mummy found in the tomb of the priestess Makare was assumed to be that of a baby, but X-rays revealed it was a baboon. At right, a papyrus shows Makare before a table of funerary offerings. Her shabit, a figure designed to serve her in afterlife, stands behind her.



The development of the X-ray in 1895 was a boon for the nondestructive study of ancient mummies. However, the costly and cumbersome equipment required at this early stage of development made it nearly impossible to use X-rays on any but a few mummies. It was not until December, 1966, when an X-ray unit of sufficient portability had been designed at the University of Michigan and a staff of qualified scientists assembled, that the Egyptian Museum collection could be examined. Only then were the internal features of the wrapped mummies exposed for analysis.

The project to X-ray the pharaohs resulted, not so much from Egyptological interest, but because a group of dentists at the university's School of Dentistry—curious about the evolution of human dentition over the past several thousand years—was studying the people of a long-neglected land called Nubia.

The study began in 1965 at Gebel Adda, about 700 miles south of Cairo. There, an expedition from the American Research Center in Egypt had been excavating an elaborate townsite and seven huge cemeteries, from which they had recovered and saved more than 5,000 skeletons and naturally desiccated bodies. The skeletons spanned a period from about the first to the eighteenth century A.D.

One of us (Weeks) had measured each skeleton and body, described any abnormalities, and taken hundreds of bone and tissue samples for later laboratory analysis. It quickly became evident that teeth best

showed physical changes and the effects of diet and environment upon health. To perform the kind of dental study demanded by a sample as large as that of Gebel Adda, a full-scale expedition was necessary. Thus the other of us (Harris), a geneticist and orthodontist interested in the dentition of ancient man, was asked to direct the project, and in 1965 he and his staff arrived in Gebel Adda.

Nubia was the logical place for such a study. The Gebel Adda material offered a large collection of human remains spanning nearly two thousand years, and the contemporary descendants of these early inhabitants, living in new villages near Aswan, provided the continuity for determining dental evolution. In spite of many foreign incursions, the group as a whole has remained remarkably homogeneous; thus the confusing picture presented by heterogeneous American and European populations would not be an obstacle here. The Nubian population showed some interesting dental features. Crowding, for example, a condition in which the teeth are poorly aligned, is thought to result from man's jaws having become increasingly smaller as he has evolved, while his teeth have remained about the same size, at least for the last several thousand years. The project found evidence to support this theory. Modern Nubians have smaller faces, smaller jaws, and more crowding of the teeth than their ancestors had. Among contemporary Nubian schoolchildren, the facial skeleton grows very slowly, while the permanent teeth erupt at even an earlier age than among American children. This disassociation in development greatly facilitates study of the etiology of malocclusion.

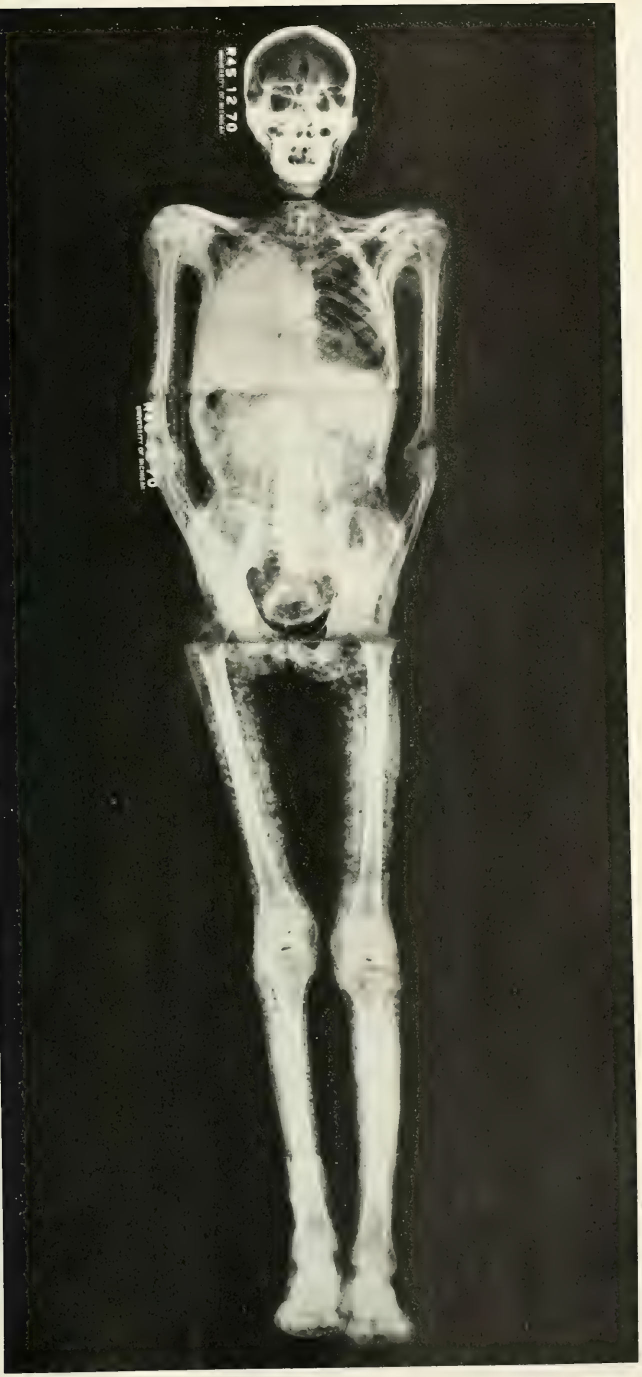
When the Nubian study was completed, we wanted to examine some noble mummies to see if the richer, more varied diet expected in a higher class had any significant effect on dentition.

After examining the mummies of officials and lesser nobles at Gizeh and Thebes, we sought permission to X-ray the unique collection of royal mummies, spanning the broadest range of Egypt's history, in the Egyptian Museum. The museum was interested; these mummies, which had still not been completely studied, promised a great deal of information, not only on diet and social class in relation to dental health but also on a number of other important questions that were perplexing Egyptologists. In December, 1966, work was begun by the first of four expeditions to the Egyptian Museum.

One of the most interesting mummies was that of one of the best-known Egyptian kings, Ramses II. No pharaoh of ancient Egypt engaged in more obvious self-aggrandizement, erected more temples and shrines, or described his military exploits in greater detail than did Ramses II, often called Ramses the Great. No pharaoh boasted of having more children (more than one hundred sons), and indeed, few reigned as many years (sixty-seven).

Ramses II came to the throne in 1304 B.C., after some years as coregent with his father, Seti I. He was

Taken from the side, an X-ray of the feet of a ruler named Siptah shows that one foot was deformed. The bones of the healthy foot extend across the bottom part of the picture. The much smaller, deformed foot is at the left. Once diagnosed as a clubfoot, the ailment now appears to have been a case of poliomyelitis.



brash, not overburdened with intelligence, and singularly lacking in taste. He carved his tomb in the Valley of the Kings. Larger than his father's, it was poorly decorated and set in an ill-chosen and badly engineered site. Today the tomb is closed because of its dangerous, crumbling condition.

X-rays of Ramses II and his successor, Merneptah, show considerable similarity in their dentition, and both are similar to that of Seti I. The large noses of all three, made more dramatic by embalmer's packing, also show a close relationship between them. Ramses II suffered from heavy dental wear and from what must have been painful abscesses, clearly indicated by the X-rays. Several of the teeth are loose in their sockets, and the heavy pitting of the bone around them shows this to have been a condition that had developed over a long period during life. Despite such dental problems, both Ramses II and Seti I show well-spaced and properly aligned teeth with none of the protrusion of the incisors characteristic of many early Egyptian rulers. Good dental hygiene would have saved both rulers considerable discomfort.

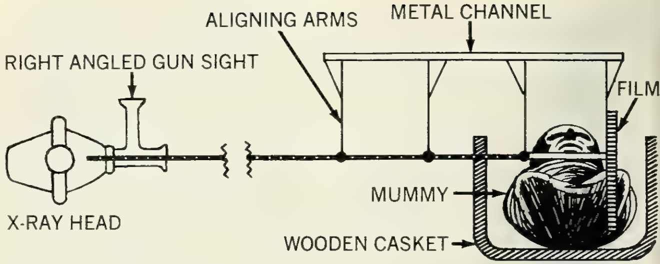
Ramses II must also have been plagued by cold feet: X-rays show severe degenerative arthritis in the hip joint and arteriosclerosis of all the major arteries of the lower extremities. Such disorders often produce circulatory problems and make movement painful.

When Ramses II died in 1225 B.C., he had outlived twelve of his hundred sons, and his thirteenth son, Merneptah, was crowned pharaoh.

Merneptah must have been more than fifty years old when he assumed the throne, and he inherited a difficult job. During his reign of

In this composite X-ray of the mummy of Thutmose I, the right lung can still be seen in the chest. The fuzzy image around the legs and feet is the wrapping.

All mummies were aligned exactly the same way for X-rays so the results could be compared. A typical result is the skull of Ramses II, below, who apparently suffered more dental wear and abscesses than any other ruler of ancient Egypt.



about twelve years there was little new construction at home, the military situation was precarious, and the impression was that Egypt was on the decline.

Merneptah's mummy was found in the tomb of Amenhotep II, and it shows him to have been an old man, partially bald and corpulent. Few royal mummies have shown so clearly the desirability of X-ray studies, for few rulers suffered so many pathological conditions, almost all of which would otherwise be invisible without careful dissection. The cervical vertebrae show severe degenerative arthritis; the blood vessels of the thigh reveal evidence of arteriosclerosis; there are signs of fractures in the heads of the femurs (the thigh bones); and there is a hole (made after death?) in the right side of the cranium.

The body was badly treated by tomb robbers. An ax or knife driven through the shoulder split the right clavicle. The right arm was wrenched from place and an enormous hole was hacked through the abdomen.

Merneptah is believed to have been the pharaoh of the Exodus. The heavy incrustation of salt on his skin has led some writers to claim that he drowned in the Red Sea, but the brine solution in which mummies were placed easily accounts for the salt on his body.

Like his father, Merneptah suffered from extremely poor dental health. The few remaining teeth show only moderate wear, but all the molars and premolars have been lost, and there is considerable evidence

of bone loss and of periodontal disease. In examining the areas of missing teeth, several dentists have wondered if they might have been deliberately removed, not just fallen out. If they were extracted, they provide almost the only evidence from dynastic Egypt of dental surgery.

Another interesting case is that of Siptah. Although he succeeded Seti II, his parentage is very much in doubt. Whatever his origins, he ascended the throne in 1209 B.C., as a minor and died seven years later.

His mummy, found in the Amenhotep II cache, is particularly interesting from a medical standpoint because of the severe deformity from which he suffered. His left foot has generally been diagnosed as a clubfoot. But Dr. Walter Whitehouse, the radiologist on the Michigan expedition, has pointed out that the over-all shortening of the entire right leg and the atrophy of the soft tissues indicate the presence of a neuromuscular disease in childhood. The disorder that generally produces such results is poliomyelitis. Because polio has been identified only once before in dynastic Egypt, and then only tentatively in a relief carving of late date, the medical implications of Whitehouse's diagnosis was a major finding of the expedition.

Siptah's teeth are in good condition and show that he died in his late teens or early twenties. The question of his parentage has not been solved by X-ray examination, but there is no doubt that he shows less similarity to earlier rulers than one would hope for to confirm direct biological relationship.

At a time when the high priest of the most important temple came to have at least as much power as the pharaoh, the women of the temple came into great power and prestige in their own right. One, Makare, is shown in a temple relief as outranking another woman who was referred to as the "King's bodily Daughter, Great Kings' Wife, King's Mother, Mother of the God's Wife of Amon, Mother of the God's Votaress of Amon, God's Mother of Khonsu the Child, and First Great Chief of the Concubines of Amon." Makare herself is referred to as simply "God's Wife of Amon at Karnak," the highest position a woman in the temple could attain.

Makare died at a relatively early age, and an examination of her mummy indicates that she died either during childbirth or very shortly thereafter. Even the packing of her abdomen by the embalmers was done to indicate that fact. It had been assumed that Makare's child was a girl named Moutemhet, who died in infancy and was buried with her mother. It is now clear that the name Moutemhet belonged to Makare herself, and that the small mummy placed in her sarcophagus is not a child at all but a female hamadryas baboon. Certainly, the X-ray examination of the mummy of the high priestess Makare and her "daughter, the Princess Moutemhet" in 1968 generated more interest than any other aspect of our research in the Egyptian Museum.

Presumably, therefore, Makare's child survived its mother, but scholars are completely ignorant both of its career and of its father. They are not even certain that Makare was married—the God's Wife of Amon, some believe, was supposed to be a virgin—and it is quite possible that the child was a result of the ritual temple prostitution later writers describe as having been prevalent at this time.

A number of possible explanations for the burial of a baboon with Makare come to mind, but none seem completely convincing. In Egyptian religion the baboon was associated with Thoth, the god of learning, knowledge, and science. In later times a small piece of cloth with a baboon painted on it was often included in burials to provide "inner warmth" to the otherwise cold corpse. But from such associations of baboons to the actual burial of one with the mummy is a fairly big step.

Some scholars have wondered whether the baboon was a substitute for Makare's infant. If she had died during childbirth, they argue, might it not have seemed appropriate to bury at least a substitute child with her for the afterlife? There is no evidence for this, but it is an interesting—and not unpleasant—idea.

These kind of results are important both for Egyptology and medical history. The X-rays of the mummies have shed light on the various diseases from which Egypt's rulers suffered and have provided a much better picture of ancient medical and dental problems than texts alone could give. They have shown that the previous calculations of the ages at which various pharaohs died are incorrect, and therefore parts of the chronology of ancient Egypt will have to be altered, in some cases drastically. The X-rays have also shown that the genetic relationships among the members of the ruling families are by no means as clear-cut as was once thought. While the kings of the early Eighteenth Dynasty closely resemble one another, as do those of the early Nineteenth Dynasty, an enormous difference between the two groups is evident. Clearly the rulers of ancient Egypt do not form a single genetic line, and the royal family tree will have to be revised.

Even information on cultural practices was revealed through X-rays. For example, the X-ray of Makare, the high priestess, showed that she had been buried, not with an infant daughter as had been thought, but with a baboon. It was found that circumcision, thought to be universal, did not always occur. Statuettes and other religious symbols and jewelry were also discovered inside of mummies. As the project continues, it is hoped that it will reveal even more information about how the ancient Egyptian ruling class lived and died.

The 13 Steps of Mummy Making

Long before Egypt became a great civilization 5,000 years ago, a strong belief in an afterlife led its inhabitants to attempt preserving the bodies of their dead. These ancestors of dynastic Egypt wrapped their dead in linen sheets or hides or mats, drew their knees up under the chin in an approximation of the fetal position, and buried them in shallow desert graves. In the hot sand a natural drying of the body took place, leaving soft tissues in a well-preserved state, with the ap-

pearance of old leather. This natural desiccation, and hence preservation, of the body was not nearly so effective when the Egyptians began building tomb chambers deep in the ground, where the body was not protected by the hot, dry sand. It may have been this change in burial practice that inspired the development of artificial techniques for preparing the dead, so that all bodies might be preserved and retain a lifelike appearance.

During the first two dynasties of the Old Kingdom, bodies were simply wrapped and placed in coffins; it quickly became clear that this did not protect the body, even when a stone sarcophagus was used. By the Third Dynasty embalmers began removing the parts of the body that decay the fastest, the internal organs, through a small incision in the body. More importantly, they began treating the body with natron, a mixture of sodium bicarbonate and sodium chloride (salt), to remove any liquids that might hasten decomposition.

Even with these refinements, the process did not work very well. We still have the Great Pyramids built during this era, but very few Old Kingdom mummies have survived to the present. Centuries of trial and error followed before mummification reached its peak in the New Kingdom, a period that extended from 1570 to 1080 B.C. As the illustrations indicate, New Kingdom embalmers eventually perfected techniques that enable us to easily identify persons who have been dead for 3,000 years.

Perhaps the best description of the process has been put together by Zaki Iskander, acting director-general of Egypts' Antiquities Department. He divides the process into these 13 steps:

1. Shortly after death—exactly how long after is not known—the body was carried to the *Per-nefer*, the "House of Mummification," or to the *Wabet*, the "House of Purification." The clothing was removed and the body placed on a large wooden board.

2. The brain was extracted through the nostrils. A small chisel was used to pierce the bones of the nose, then a hooked wire was passed through and the cerebral matter removed. The brain could also be removed through a hole made in the skull, but this was an extremely rare variation. In no case was the brain preserved with the other organs, probably because the Egyptians did not assign to the brain any special or important functions.

3. An incision was made in the abdomen, and all the contents, except the kidneys, were removed.

After the abdomen was cleansed, the diaphragm was cut and all the contents of the chest cavity, except the heart, were removed. To the Egyptians the heart, not the brain, was the seat of mind and emotion, the organ that recorded for the gods all the good and evil deeds one did during life. In religious scenes, the heart of the deceased was shown being weighed against the symbol of truth to determine whether or not the deceased was worthy of heaven.

4. After the internal organs were removed, the chest cavity and abdomen were washed with palm wine and spices.

5. The viscera were washed separately and placed in a container of natron for forty days. After being sprinkled with perfume and treated with hot resin, they were wrapped in packages and placed in four containers called canopic jars. The head of a deity was carved on the lid of each jar.

6. To speed the dehydration process and prevent any disfigurement of the body, the abdominal and chest cavities were next packed with temporary stuffing materials: sand, straw, resin, rags, dried vegetable fibers—one gets the impression that anything handy was used.

7. According to Herodotus, seventy days probably represented the time required for the entire mummification process. Almost half that time was needed for dehydration, since any remaining fluids could destroy the body. This was accomplished by placing the body on a sloping board and covering it with heaps of dried natron. The time required for this operation has been the subject of dispute; the "forty days" mentioned in the Bible (Gen. 50:2-3) is perhaps an allusion to this: "And Joseph commanded his servants the physicians to embalm his father: and the physicians embalmed Israel.

"And forty days were fulfilled for him; for so are fulfilled the days of those which are embalmed: and the Egyptians mourned for him threescore and ten days."

8. After the dehydration process was completed, the body was removed from the natron. The temporary stuffing was taken out and, since it had come into contact with the dead man, was not discarded but set aside. The body was washed with water and palm wine and carefully dried.

9. Resin or resin-soaked linen was then placed in the cranial cavity, and sawdust, myrrh, or occasionally onions—carefully wrapped in small linen bags—were stuffed into the abdomen. The abdominal incision was then sewed up, often rather crudely, and in some cases a small plate of gold or a beeswax seal was placed over it.

10. The body was next rubbed with a mixture of cedar oil, cumin, wax, natron, gum, and possibly milk and wine, then dusted with spices.

11. To restore a lifelike appearance to the face, the cheeks were padded with linen and the nose was plugged. Small pads of linen were placed in the eye sockets, and the eyelids were closed.

12. To strengthen the skin and to prevent moisture from entering the pores, a thick coating of resin was applied to the entire body.

13. Occasionally eyebrows might be painted on the face or jewelry used to decorate the body. Bandaging usually began by wrapping each finger and toe separately, then each limb, and finally the body as a whole. Everything that had

Continued on page 78

The mummy of Yuya, father of an Egyptian queen, is so well preserved that stubble can be seen on his chin. X-rays revealed that many teeth were missing.

Beyond the Yukon

Hidden from the river is a land that makes hunters forget to hunt

The most enjoyable way to travel the Yukon Territory is by raft on its natural highway, the Yukon River. It costs next to nothing, you can establish yourself in comfort, and the river does the traveling for you. Air and scenery are at their best, and since the river carried the traffic of the country for most of its history, historic sites are plentiful right along its banks. In fact, traveling the Yukon by raft is so enjoyable that one can only marvel at the single-mindedness of the Klondikers to get it over with and start digging.

But to really see the Yukon Territory, traveling the Yukon River is not enough. The territory is mostly mountains, and for the first five hundred miles you hardly see any true mountains at all from the river. Not until Dawson City do you approach a major range, and only at Forty Mile, a still older gold town, does it draw into full view.

The mountains you see there form the southwest flank of the Ogilvie Ranges. Until the last decade these ranges were the least-known in Canada, and thus presumably on the North American continent—another startling testimony to the single-mindedness of the early Yukoners, considering that their

by Bob Skovbo

photographs by Paul von Baich

"The river does the traveling for you."

capital lay virtually at the foot of these mountains and that their highway, the Yukon River, skirts them by a few miles. But there wasn't much gold to be found in the mountain creeks, so the miners didn't bother with them any further.

A few trappers, prospectors, Royal Canadian Mounted Police patrols, and Indian bands roamed the mountains at one time, but they left scant records of their travels, and have now virtually abandoned the country. Their place has lately been taken by geologic exploration parties and a few hunting outfitters, and a road-building crew is pushing north toward the Mackenzie Delta. By their topographic definition, the Ogilvie Ranges cover an area of some 15,000 square miles, so there is still room for anyone wishing to roam a true mountain wilderness. But the river tourists, true to tradition, continue to pass them by.

Although I had been in the country before, we had traveled with boats on that occasion, and I knew little of the terrain away from the river. The overland route we picked for this trip proved to be not the most convenient for backpacking. The local game outfitter prefers a route four times as long, and the boundary survey crews that operated in the area early in the century found conditions so difficult that they abandoned most of their horses—and in some cases even clothing and bedding—to break back out to the Yukon River. Their traverse was, of course, much more extensive and arduous than ours, but the terrain can be trying even when you don't have to cut through in a straight line and only have a short distance to cover. What with bad weather, big loads requiring relays, untrained legs, photographic work, scouting excursions, and a return trip to the nearest settlement for new boots for me, it took us three weeks to cover the 20 or 25 miles to our destination, instead of the one week I had predicted.

We entered the region through the valley of the Tatonduk, a small river that flows into the Yukon some 28 miles downstream from Eagle on the Alaska side of the border. Our destination was a minor range on the Yukon side whose most prominent feature is marked

Sheep Mountain on the local maps.

This formation is a prodigious limestone escarpment sculptured in the manner of the "rock castles" of Utah and Colorado, albeit on a more modest scale, and represents only one of many similar outcrops in that area. In size and impressiveness these formations may well be unmatched in Canada—I certainly know of no others like them—but nobody I had met in the Yukon or at Eagle seemed to know of their existence. We planned to make them the principal object of our trip.

The Tatonduk is a typical mountain stream—swift, clear, shallow,

"It bursts into countless chutes and rapids."

"Here you have a subarctic landscape at its greatest."

unruly, and cold. For a few miles above its mouth, and again at its headwaters, it braids profusely over wide gravel bars, but for most of its course it stays in a well-defined bed. Apart from filamentous algae, it is devoid of vegetation; even its few slow, meandering arms appear largely lifeless. The salmon of the Yukon are not known to ascend it. Apart from little sculpins lurking by the water's edge, the only fish we noticed in the Tatonduk were whitefish and arctic grayling.

This is not to say that the stream is dead or uninteresting. With due allowance for the affection one develops for streams by whose banks one has spent some of the best days of one's life and which one knows from end to end, I could not imagine a more delightful little river. Its gravel pans abound in intriguing pebbles, quite a few of them fossiliferous. It bursts into countless chutes and rapids, and in its uppermost gorge, plunges over a falls some fifty feet high. Nor is it always just a delightful little river. Where

it breaks through the mountains it has cut a canyon with one sheer wall 700 feet high, the other rising to some 500 feet and on up into the hills. You don't see this place when you backpack into the highlands, but it is well worth a side trip.

And though the waters of the Tatonduk are too cold and active to support much life, the valley bottomlands they have built up support the richest biome of the region, at least in terms of biomass if not in variety of species. On the terraces formed by the river occur the most extensive stands of tall timber: cottonwood, or balsam poplar, on the younger formation; white spruce and paper birch on the older, with an understory of willows, alder, soapberry, roses, highbush cranberry, currants (both red and black), and some flowering dogwood, here at the limit of its range. Quite a few of the spruce are two feet thick at chest level and fifty to seventy feet high, and the cotton-

"Living in the bush, one's interest in berries tends to be more than purely botanical."

"A typical mountain stream—swift, clear, shallow, unruly, and cold."

woods aren't much inferior. Black spruce muskegs with the usual mat of mosses and Ericaceae tend to occur on the older and higher alluvia, and on dry, sunny bluffs aspen and prickly juniper grow, as well as occasional gooseberry shrubs, which also seem to favor these sites.

Perhaps the most intriguing, although hardly the most beautiful, plant growing in the shade of these woods is the alder root parasite *Boschniaka rossica.* Its brown, cone-shaped spikes sprout from the moss in many places and, together with extensive light-green mats of fleecy horsetails, lend a distinctive appearance to the forest floor. I have never seen this parasite outside the Yukon–Alaska region, nor such vast mats of horsetail growing in the woods. Incidentally, *Boschniaka* is one of the many floristic links between the Yukon–Alaska region and Asia that one can see here, that lend such a unique perspective to botanizing in these parts.

Living in the bush, one's interest in berries tends to be more than purely botanical, however, and I believe few kinds eluded us. But apart from the insipid pinesap and the not much superior bearberry, most varieties were not at their best in the valley.

August is also not the ideal month for birding. The small passerines, which are usually most readily recognized by their song, tend to pass unobserved. The only species still in full voice was Traill's flycatcher, but the call of this inhabitant of waterline thickets is more notable for persistence than for melodiousness. Another bird whose song is still heard in the mountains in August is the varied thrush, but again it is not a remarkable effort, romantic reports to the contrary notwithstanding. The only common river birds were kingfishers and spotted sandpipers, although at the river's mouth, red-throated loons were regularly seen fishing. An occasional harrier, too, patrolled the river flats there. The presence of a fair number of ruffed grouse in the poplar–spruce stands by the river's mouth might also be worth mentioning, considering that this may represent a northern limit of their range; indeed, none were seen farther up the valley, where the spruce grouse replaces them.

One cannot leave the valley without mentioning its rocks. They outcrop in a bewildering variety of exposures, and although the untrained eye can do little more than marvel at their fascinating structures and tints, it is evident from published reports that they are no less fascinating to the geologist. They represent an exceptionally condensed and complete sequence from the Mississippian to the Lower Cambrian period of the Paleozoic era, a range of 310 million to 550 million years before the present. Only the Pennsylvanian and Permian are absent, and rocks of these ages are found in abundance farther upstream, culminating in the great castellations of the Sheep Mountain cuestas, which bring the Paleozoic exposures of the region to such a splendid conclusion. Along the lower Tatonduk, as you struggle up the first prominent bluff by the river, you are, figuratively speaking, climbing down the ladder of time in the opposite sense. Crossing the threshold of the Lower Cambrian into the Proterozoic, you continue on over outcrops of banded shales, colored flesh pink to deep oxblood and fractured into steplike patterns of the most delicate and detailed symmetry, while on your left, red beds of the same age outcrop high above the forest. After some three miles a fault terminates the succession and a great wall of Cambrian cliffs closes in on the river, putting a stop to further travel in that direction.

Just walking over these rocks is enough to prompt all sorts of reflections on the record they trace—how much time a single footstep can span; how a single, delicate band can stand for an age longer than it took to raise the tallest mountain in sight; how much life has vanished across the invisible gap of a disconformity; and how the horsetails and club mosses brushing your boots grow on the very rock in which their ancestors—giant horsetails and lepidodendrons as tall as the trees that now shade their descendants—may now lie buried.

Where rocks shape the land, you must shape your course accordingly, and at the great cliffs by the Precambrian–Paleozoic fault you must leave the valley. A short haul brings you to the next region, one we called the Boundary Mountains.

Short as that haul is, with it you enter another country altogether. Steep slopes rise on every hand, creeks gush from narrow valleys over boulders and rubble, and the scent of leafmold is no longer in the air. This is highland air, which sweeps over the crags and pinnacles you see rising above the timberline spruce wherever the slopes meet the sky. You are in the mountains now.

The pale gray and bone-colored crags you see here are all outcrops of one formation, the Jones Ridge Limestone, a massive accumulation of beds thought to have originated as a shoal or reef in the offshore waters of a Cambrian–Ordovician sea that must have covered the area with little interruption for some 150 million years. Erosion has shaped it into spectacular and distinctive structures—jagged, precipitous spurs with "windows" worn through the rock, massive rock castles, and groups of pinnacles whose shapes seem to copy on a gigantic scale the conical outlines of the spruce often seen growing among them, to give an arrangement curiously reminiscent of the fanciful mountainscapes in early Renaissance paintings. The upper Funnel Creek Valley in particular, flanked by Nimrod Peak on one side and Squaw Mountain on the other, displays a marvelous variety of these structures. These mountains rise to about 5,000 feet, and to the northwest are succeeded by a yet taller mountain, the Jones Ridge, after which the entire formation is named. Its upper beds, especially, are highly fossiliferous in places, and the lower contain beautifully preserved examples of the spongelike *Archaeocyathus,* which flour-

Continued on page 80

Waiting for the Phone to Ring

By and large, readers of this column tend to be open, friendly, optimistic people. Most believe we should not only listen for signals from intelligent beings elsewhere in the galaxy, but that we should also do more to let them know we are here.

This, at least, is the impression I received from readers who responded to the invitation for ideas on this question in the April "Sky Reporter." A few did argue that contacting other civilizations could be a mistake, that some more powerful kind of beings might crush us like an annoying anthill. More pointed out that we humans have no little difficulty communicating with each other here on earth, much less with fellow inhabitants like porpoises, so we cannot expect to communicate very well with truly alien creatures.

The April discussion started with the plaque attached to the Pioneer 10 spacecraft, now hurtling through the asteroid belt on its way to Jupiter and eventually out of the solar system. The plaque, reproduced below, is our first deliberate attempt to communicate with extraterrestrial beings; its message includes what we look like, where we are in the galaxy, and what we think would be a good radio wavelength for communication.

The plaque was an afterthought for the Jupiter flyby, hurriedly designed by Frank Drake and Carl Sagan at Cornell University. Some of our readers would have done it very differently. For example, Bunnie Hall of Live Oak, Florida, wrote:

"But if . . . they receive our message, I am sure that within a thousand years they can interpret enough of it to know there is a nudist colony somewhere in outer space. We have had considerable trouble interpreting some of the messages left by our early ancestors and failed on some. And they were simple and unscientific.

"I think by all means we should try to contact anyone out there, but why blow it if we should. Why not use a simple 'Me Tarzan, you Jane' type of picture message that could be interpreted by simple people like us on earth?"

Others felt that the picture of the man and woman on the plaque offered too narrow a view of earth life. Virginia Radcliffe of New York City reacted this way:

"Assuming it's wise, other worlds to illumine—
We attempt to show life as exclusively human.
But graffiti celestial
Can't avoid being bestial
When they picture two Wasps as the man and the
woman!"

The Reverend Kenneth J. Delano of Fall River, Massachusetts, was more specific:

"In our communications attempts we should try to make it clear that we like to show kindness and love toward others, not just toward our own species. For that purpose it would be advisable to depict not merely a man and a woman (as on the Pioneer 10 plaque), but perhaps the representation of a man and woman in the company of, or offering food to, creatures altogether different from themselves, such as four-footed animals or birds. We are more likely to get a response if we are recognized as being willing to show good will to nonhumans."

No one seemed to doubt that we have the physical capability of sending messages across deep space, but many doubted we were ready to meet the rest of the galaxy. Robert Baker of North Glenn, Colorado, asked:

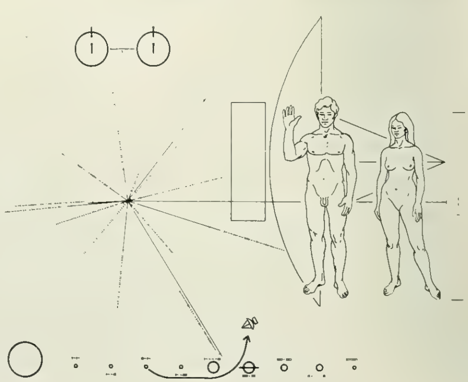
"And what about racial discrimination? This may reveal the biggest problem of all on facing up to extraterrestrial life. But this time it isn't just cultural and pigmentation differences, but an entirely different concept of being and a totally different historical background.

"Brother, if I feel like an alien and an outcast on my own planet, just think what these poor fellows would go through if communications were to be immediate and interpersonal. Should we not do something about this?"

Gene Weeks of Earlysville, Virginia, feared aliens might be appalled by the way we are messing up our planet. "I do not believe it wise to invite our neighbors in for coffee until we have cleaned house," he concluded.

If we do send further messages, what should we say? Charles Bigelow of Portland, Oregon, suggested:

"It is difficult to say what messages to send, or guess what we might receive, when as yet we know so little of communication on earth. What stories do the crows tell on winter evenings in their citylike roosts? What would the ants say of their vast altruistic and to-



by John P. Wiley, Jr.

talitarian societies? And do porpoises discuss the currents and blooms of the oceans as farmers gather to talk about the weather and crops.

"If we receive an answer, then we may as well send back everything we know—Tacitus, Schrödinger, Mao, and Matisse, the dance of the bee, and the soliloquy of the raven. So that on another world, if they were willing and capable, beings could set aside their reading of *War and Peace*, and see a bumblebee on red clover, trees dancing in the wind, and the Earth buzzing and shining with a billion creatures."

A few readers were downright upset about the implications of the Pioneer 10 message. They tended to assume that other civilizations would be superior in various ways, which seems likely if civilizations on older planets circling older stars reached our present level ten thousand or ten million years ago. These readers felt we would only hurt ourselves—or the aliens—by making contact.

To Jonathan Haskett of Washington, D.C., "our messages are rather like an obnoxious drunk who goes around putting his arm around you and telling you loudly you are his friend."

R. J. Ganley of Hancock, New Hampshire, argued that it was hypocritical to send what we intended to be a message of peace, the image of the man with his empty hand raised in greeting. He argued (in the copy of an advertisement he wrote for a Keene restaurant):

"That's what really got me! Man hasn't gone anywhere in peace! Human beings speak with forked tongues and I've got 5,000 years of recorded human history that will back up my argument that any creatures that encounter this rocket had better just let it go by, or hide!"

Finally, a number of readers offered samples of messages we might receive or scenarios of what might happen when aliens intercept Pioneer 10. Here is one scenario from Richard G. Robinson of Dragerton, Utah:

"Centurion 2-20 checked the hues of lights before him. All was well, his spacecraft would take him safely home. 20 looked across the dimly lit control room; 1-103 was following the mechanical movements of the navigation system. 20 could not determine exactly why, but he found 103 as mentally abrasive as his tough epidermis. 20 lifted his own limb to a red light as a comparison. He could see the light through his semitranslucent flesh, but the light now had a bluish cast. Having a superior mind compensated him for any physical restriction he might have.

"103's call jolted 20 from his mental wanderings. 20 walked to the oval dish 103 was watching. The persistent murmurings of the navigation equipment appeared solved, reported 103. The equipment was picking up a metallic craft running a parallel course with their own ship. 'You simple fool,' thought 20; 'Impossible.' 20 routinely checked 103's conclusions without comment. Unless the machine was malfunctioning, 103's conclusion was correct. 'How could this be?' 20 wondered. Eons ago 2s had exterminated all potentially dangerous life. 20 looked into the eyes of the biped creature before him. Yes, all except some 500 1s kept for tasks considered too hazardous for 2s.

" 'Direct the craft to within physical identification range of our traveling companion.' 103 paused, then changed course. 20 knew indirectly a course change was against regulations, but that is why a 2 was aboard—to make decisions.

"20 and 103 gazed intently at the metallic object as it drew closer. 20 ordered the strange craft taken aboard. 103 complied by opening the cavity at the base of the ship. 103 walked down to the next level to see that the craft had indeed been successfully taken. As 103 gave the craft a cursory inspection, his attention was immediately caught by a sun-colored inscription. He reached to touch the inscription, but suddenly reeled back, writhing in pain. 20 shut off the frequency control directed at 103 from his midsection belt. This was the first time 103 had taken the initiative, a serious violation of standing orders. If this was an indication, after all these eons of controlled action, of 1's innate nature, it was no wonder the decision was made to exterminate the culture and civilization of the 1s. There could be no hope for creatures ruled by emotion.

"20 moved closer to the metal craft and saw what had addled 103. He saw figures amazingly close to 1s etched on the inscription. 20 studied the inscription carefully. It carried a significant amount of information requiring deciphering, but the most obvious thing was the order to stop, backed by the threat of additional spaceships and some violent force to go with them.

"The captured craft was turned over to the 3s for examination. Among the interpretations: The 1s who fled had found a new home during the extermination period. This message from them was a demand to stop the extermination. The latest home of 1s contains a tremendous source of power they are prepared to use against 2s and 3s. To show their fearlessness, they included a map of their home.

"Decisions: 3s would compute the exact location of the third planet, home of 1s, destroy their power base with a vast robot fleet with a catalyst to negate the sun's power.

"103 watched the firings, more than he could count, until the need for rest compelled sleep. The inscription had been like a shot of adrenalin to all 1s. 103 closed his eyes, knowing bondage would become a thing of the past." ■

Celestial Events

by Thomas D. Nicholson

The Moon: During August, September, and October, the moon's phases follow about the same schedule. You will find the waning crescent in the morning sky during the first week of each month. Then, for about a week before and after midmonth, the moon will be an evening object, appearing as a waxing crescent until first-quarter (about midmonth), and then a waxing gibbous moon until it becomes full about a week before the month ends. Finally, during the last week of each month, the waning gibbous moon will rise between sunset and midnight and remain until dawn. In August, first-quarter is on the 16th, full moon on the 24th, and last-quarter on the 31st; in September, new moon is on the 7th, first-quarter on the 16th, full moon on the 22nd, and last-quarter on the 29th; and in October, new moon is on the 7th and first-quarter on the 15th.

Planets and Stars: On August evenings, summer stars are high overhead, spring stars (Regulus, Spica, and Arcturus) are still prominent in the west, and the autumn groups (Pegasus, Pisces, Aries, and Perseus) are rising in the east. By October, however, spring stars have gone from the evening sky, the Summer Triangle (Altair, Deneb, and Vega) has slipped into the west, and the early harbinger of winter, Taurus, is well up in the east before midnight.

The only planet you will see in the early evening sky is Jupiter. Very bright, it appears in the south or southwest at dusk among the stars of Sagittarius, and sets about midnight or before.

Jupiter is gone by midnight, but Saturn will be rising well up in the east by then. It is still in Taurus, above and to the left of the bright red star Aldebaran. Saturn remains visible until dawn, when it will be high in the southern sky. To the left of Saturn, you will see Venus, the brightest of the planets, rising two to three hours past midnight, dominating the southeastern sky by daybreak.

Mercury can be seen as a morning star for the last half of August. Otherwise, both Mercury and Mars are too close to the sun to be observed during these months.

August 18: The reddish star near the moon is Antares.

August 19: Jupiter is close to the moon tonight.

August 25: Mercury is at greatest elongation from the sun in the morning sky, and is visible as a morning star for several days.

August 26: Venus is at its greatest westerly elongation, 46 degrees to the right of the sun.

September 1: Saturn is below the moon this morning.

September 3-4: Venus is near the moon on both mornings.

September 7: Mars becomes a morning star.

September 15-16: Jupiter is near the moon on both evenings.

September 19: Mercury becomes an evening star.

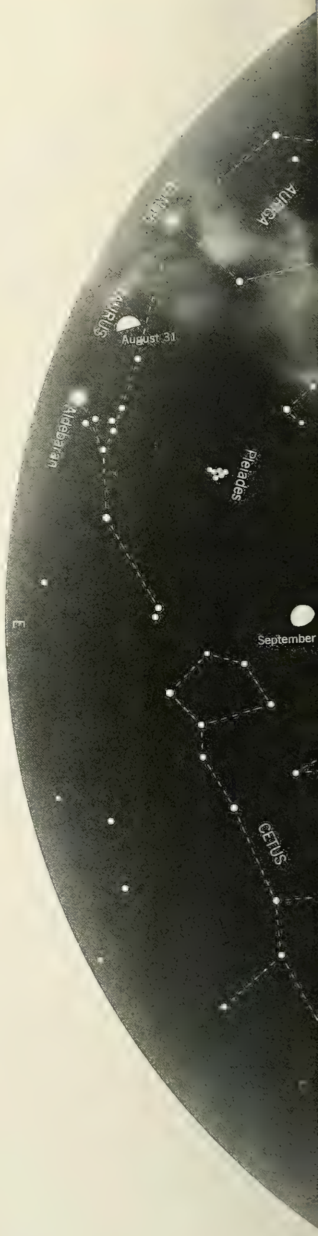
September 22: The sun reaches the autumnal equinox. Summer ends and autumn begins in the Northern Hemisphere at 5:33 P.M., EST. Tonight's full moon is the harvest moon.

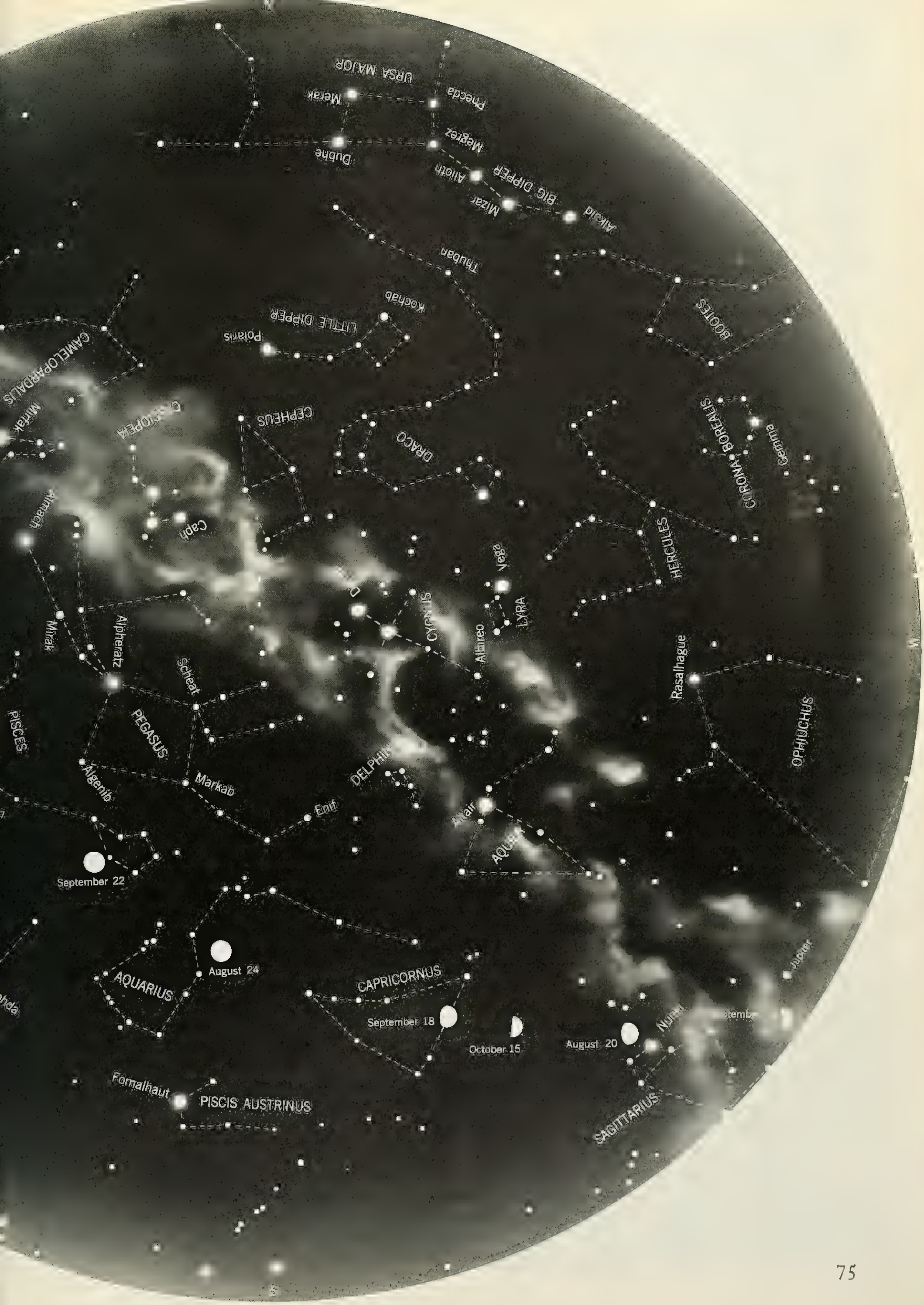
September 28-29: Saturn is near the moon again.

October 3-4: Venus is close to the moon in the morning sky. The star nearby is Regulus, in Leo.

October 13: The moon passes close to Jupiter this evening.

★Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 12:20 A.M. on August 15; 11:20 P.M. on August 31; 10:20 P.M. on September 15; 9:15 P.M. on September 30; and 8:20 P.M. on October 15; but it can be used for about an hour before and after those times.





URSA MAJOR
Merak
Phecda
Megrez
Dubhe
Alioth
Mizar
BIG DIPPER
Alkaid
Thuban
Kochab
LITTLE DIPPER
Polaris
CAMELOPARDALIS
BOOTES
CEPHEUS
DRACO
CORONA BOREALIS
Gemma
Caph
Almach
Vega
HERCULES
LYRA
CYGNUS
Albireo
Mirach
Alpheratz
Rasalhague
Scheat
PISCES
PEGASUS
OPHIUCHUS
Algenib
Markab
Enif
September 22
August 24
AQUARIUS
CAPRICORNUS
September 18
October 15
August 20
Fomalhaut
PISCIS AUSTRINUS
SAGITTARIUS

Conception and Contraception

Continued from page 52

cluding severe nausea, lessen its acceptability as a postcoital medicine.

Semen contains substances that induce the contraction of the smooth muscle of the uterus. These substances, called prostaglandins (misnamed because they are formed in seminal vesicles, rather than in the prostate as originally thought) have been the subject of intensive research in recent years, particularly by U. von Euler and S. Bergström of the Karolinska Institute in Stockholm, who first characterized them.

Prostaglandins are fatty acids and are synthesized in the body from linoleic acid, an essential constituent of the diet. Prostaglandins are found in many body tissues of both men and women, but the richest source is human semen. Some prostaglandins dilate the blood vessels with a consequent lowering of blood pressure, and some suppress gastric secretions in ulcerated stomachs, so they are of considerable pharmacological interest. Of particular relevance to birth control are certain prostaglandins that, when injected into women in the early stages of pregnancy, induce strong uterine contractions, which expel the implant within two days after the injection.

Recent clinical studies have demonstrated this to be a practical means of inducing abortion. The only side effect seems to be nausea, because the prostaglandin also causes contraction of the smooth muscle of the gastrointestinal tract. If we could synthesize a prostaglandin that is more specific for the uterus and that could be taken orally, it would be a superb contraceptive. A woman would take the substance orally or as a vaginal suppository if she missed a period. An apparent menstruation would result, with expulsion of the implant if indeed it was present.

The IUD has been known since antiquity. Prior to their long caravan journeys, Arabian camel drivers inserted a smooth stone into the uteri of their animals to prevent their pregnancy along the route. During the 1920s some gynecologists in Germany employed the IUD in the form of a collar button or a metal ring, but it fell into disfavor because of occasional infections and uterine perforations. IUDs were revived in the 1950s with the use of plastic loops, spirals, and similar objects, which expand when inserted into the uterus. They have a trailing thread to aid in their removal when pregnancy is desired or when the device is found to produce intolerable side effects. Most usually, especially after a few months, the menstrual cycle and menstrual flow become normal. In those portions of the endometrium that are in contact with the device, there is some edema.

Like any foreign body, the IUD will cause the marshaling of white cells. These phagocytes attack sperm and possibly even the implant itself. Still another possibility is that the IUD arrests cleavage of the fertilized egg.

The side effects of the IUD (pelvic cramps, irregular and particularly heavy menstrual bleeding, and spontaneous expulsion—sometimes even without the wearer's knowledge) are reduced by decreasing the size of the device, but this also reduces its contraceptive effectiveness. The small size can be compensated for, however, by winding the device with a small coil of copper wire as was first observed by Jaime Zipper of the University of Santiago. Since then a T-shaped IUD wrapped with copper has been developed and tested in field trials by the Population Council of New York. Preliminary trials indicate excellent results: namely, only one percent pregnancies with practically none of the usual side effects. Studies in our laboratory indicate that metallic copper has a profound effect on the mucoids and enzymes of the endometrium.

Considerable effort has been expended to develop a practical oral antifertility agent for men, but without much success. The development of sperm, which first occurs in puberty, is governed by the hypothalamus and involves the same gonadotrophins as with women. Although estrogens are produced in males, the typically male steroid hormones are the androgens, testosterone and androsterone. No cyclic phenomenon has been observed in men. The time of generation of spermatozoa in humans is about two months. Hence, any treatment that

inhibited spermatogenesis would have to be applied only every other month.

Cadmium salts have a sterilizing effect on males through the destruction of cells in the scrotum, but are not being seriously considered because they promote hypertension and other, toxic effects. Mutagenic agents used in the chemical treatment of cancer are effective in arresting spermatogenesis but are likewise considered too toxic.

One oral agent, a diamine, which stops the generation of spermatozoa and which is not toxic, has a curious side effect, an intolerance to alcohol. This compound apparently forms complexes with substances that are required in the oxidation of aldehydes produced in the liver by alcohol. As a consequence, a man drinking even a small amount of alcohol after taking the pill (as was indeed the case to celebrate the success of the experiment) suffers a severe hangover. It could be argued that this pill would simultaneously solve two major ills, namely alcoholism and overpopulation, but in our present society this argument might be hard to sell.

A practical method of effecting male sterility is vasectomy. This is a minor operation consisting of ligation of the tubes leading from the testes. Vasectomy has no effect on male sexual physiology and after two months the semen contains no sperm. The method is quite widely accepted, and in the past decade perhaps two million such operations have been performed in the United States and India. Similarly for women, ligation of the ovarian tubes is a simple procedure for effecting sterility.

There is no single completely satisfactory contraceptive method; each one has its drawbacks. Presumably, the combined efforts of scientists from various disciplines, armed with expanded knowledge of the details of human reproductive physiology, will evolve new methods that are most appropriate for a given sociological situation. Sociologists agree, however, that it is equally important to inculcate in the masses a recognition of the dangers of overpopulation and a strong personal need to restrict the size of the family. Meanwhile, the population time bomb keeps ticking away. ■

X-raying the Pharaohs

Continued from page 62

touched the mummy during these thirteen steps, including the stuffing materials, was now carefully gathered together, packed into sixty-seven large pots, and buried near the tomb of the deceased. This was necessary, for it was thought that the possession of so much as a hair of the deceased's head by an enemy would provide a means of bewitching him.

Placed in his coffin, accompanied by priests and mourners and members of his family, the deceased was carried in procession across the Nile to his tomb on the west bank of the river. So that the deceased might enjoy in the afterlife all that he had enjoyed in his lifetime, ceremonies were performed to restore his ability to see, hear, speak, move, and eat.

Did such ceremonies work? The Egyptians believed they did, and belief in the magical properties of mummies has persisted through the ages. Less than four hundred years ago, powdered mummy—ancient human flesh, finely ground—was prescribed by physicians as a treatment for epilepsy, heart murmurs, nausea, poisoning, paralysis, tuberculosis, cuts, bruises—in short, almost every known ailment.

Genuine ancient Egyptian mummies, rather than the naturally desiccated bodies one finds in any desert country, were especially favored by physicians, and by the late 1500s an extensive trade had developed to locate and ship such mummies to druggists throughout Europe. As the demand for mummies increased, enterprising merchants "manufactured" artificial mummies, exhuming bodies from local cemeteries and drying the cadavers to produce a substance that at least looked like the real article. Some physicians of the time, such as Ambroise Paré, criticized the use of mummy, claiming that it caused "many troublesome symptoms, as paine of the heart or stomake, vomitting, and stinks of the mouth." But its use has continued. Even today there is a regular, although admittedly not heavy, demand for genuine powdered Egyptian mummy at a New York pharmacy catering to witches. The cost is forty dollars an ounce. ■

Beyond the Yukon

Continued from page 71

ished only in the early Cambrian.

Beautiful as the lower Tatonduk Valley is, you have to get into these hills to see the country at its finest. For some distance up the narrow valley bottoms the vegetation does not differ greatly from that by the Tatonduk. Cottonwood and black spruce, viburnum and soapberry are less prevalent, and dogwood is no longer seen, but otherwise it is much the same, and big white spruce still occur, ascending the slopes almost to timberline at about 3,500 feet. With their broadly spaced trees and well-drained forest floor covered in berries and mosses, with a sparkling creek purling and gushing beside a well-trodden moose trail, these ribbons of forest can be enchanting places to travel.

But if you are heading for higher ground, you will soon reach the willows in which these ribbons tend to trail off; indeed, even if you don't want to go into higher country, something will be in your way, even if it is only the creek itself, which the trail constantly crosses and which the moose don't mind, but which can be tricky for a biped with a pack. In the steep heads of the valleys, where the creeks are lined with willows, you often have to walk up the creek itself, hopping and teetering from boulder to boulder till you lose heart and crash back into the shrubs. This, together with negotiating loose rockslides by dint of similar acrobatics, is doubtless the riskiest part of backpacking through that country.

You are richly rewarded for your efforts. Scenery, flora, and fauna are at their most varied and contain much that you are unlikely to see in more settled parts.

Much has been made of the edible plants of the north, but if you have ever watched a grizzly rooting for them, you realize what it takes in the way of physique and application to make a meal of these plants. We tended to stick to berries and mushrooms. These can be picked as you go along, and in a good year they will supply all your vegetary needs. Nineteen seventy-one was an exceptionally good year for berries and mushrooms in the northwest, and we must have consumed bushels of bilberries, cloudberries, lingonberries, crowberries, red and black bearberries, red and black currants, raspberries, rose hips, and to go with our stews and meat, boletes, agarics, and coral mushrooms. A few other edible berries and a multitude of edible mushrooms occur, but in such a year you need pick only the choicest kinds.

Rare flowers and huge crops of mushrooms were not our only unexpected finds in the Boundary Mountains. Climbing a talus slope one raw and rainy morning and vaguely thinking about the possible meaning of the fresh grizzly diggings in the vicinity, I was suddenly stopped in my tracks, not by a grizzly, but by something much more astonishing—a little gray, white, and black bird called the wheatear. This astonishing bird, thin in beak and limb but bold in posture, seems about to invade our continent via a remarkable pincer movement across its extreme northern frontier: Alaska on the west and northern Labrador, Baffin, and even Ellesmere Island on the east. We were in the Yukon by then, where I thought, wrongly as it turned out, it had never been recorded. But for me it certainly made the day, especially when I later came upon the female with her young.

As morning dawns in the valley you are sure to hear the strange, sustained note of the varied thrush. In August it is rare to hear a snatch of this solitaire's song, one of the loveliest sounds in the mountain wilderness. But you see the bird often, and above timberline you will catch sight of finches, bounding through the sky in loose flocks and suddenly descending as if strewn from the clouds to busy themselves among the rocks and lichen. Few sights convey better the freedom of those open spaces than a flight of rosy finches. But everything you see embodies this sense of freedom in one way or another—a white-and-brown ptarmigan clearing a ridge on set wings, a kestrel turning in the wind, a golden eagle cruising, the sharp trill of a gopher from the ridge opposite, the white mountain sheep grazing there. So does any spread of valleys and hills beneath you, with the great redoubt of Sheep Mountain in the distance. For you can see it now wherever you "top out."

But before you reach Sheep

Mountain you must first descend from the Boundary Mountains and traverse a number of valleys and ridges, depending on the route you choose. The variety of landforms you encounter here is perhaps the most remarkable of the entire trip. There is first a zone of strangely convoluted and deeply gullied hills of brittle shale weathered to the magical tints of a Persian miniature—silvery gray, mustard yellow, and in places, brick to blood red, dotted with feathery birch and the dark minarets of spruce. Then long spurs lead up to a high, smooth ridge of herb mats and heather; the next ridge outcrops in a succession of humps that look like the dorsal spines of a dinosaur; the next again, which affords the best route but is better reached by another approach, is ribbed by parallel ridges of conglomerate many miles long and weirdly reminiscent of some gigantic defense system, the ruins of some multiple Great Wall of China. In the folds between these tracts of highland you can camp by creeks under well-spaced timber, protected from the weather and supplied with all the amenities the wilderness has to offer. No country more thoroughly belies the popular conception of the north as a bleak and forbidding place.

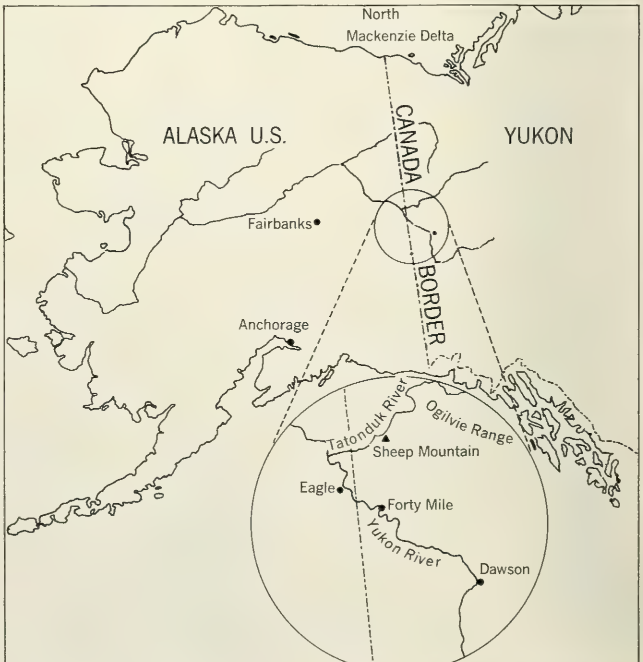
Presently you regain the Tatonduk, cross it at some fordable spot, and pack into Sheep Mountain. The cuesta of Sheep Mountain proper faces south, and we set up our base camp in the first suitable wooded gully at its back. From there, we made excursions ranging over the deeply dissected upland of hogbacks, mesas, escarpments, and small canyons stretching some twenty miles from the Tatonduk River to its gradual termination a little beyond a small lake in its eastern reaches, which we called Meeting Lake (in disregard of its actual but still unofficial name, Callison Lake). We also rounded and crossed the two associated formations, Mount Deville and Mount King. But we spent a good part of our time, as before, sitting in camp waiting for better weather and watching the antics of the whisky jacks (Canada jays), which had befriended us.

We saw no unusual plants or animals in the three weeks we spent in the region. What we saw were its

traditional inhabitants—grosbeaks, rosy finches, redpolls, pipits, ptarmigans, golden and bald eagles, white Dall sheep, moose, a wolverine, a black bear, a grizzly. This is the country of the golden eagle, the Dall sheep, and the grizzly, so to sight just one grizzly and not a single ram with a full curl is not an impressive record. Just to step onto the rim of an escarpment and look out over the immense spread of that country should be enough for any man. When you ask an Indian or an Eskimo why he went somewhere, he will often tell you, "To see the land." Even to him, the hunter, the rest is incidental. This land is to be seen in that spirit.

Here you see a subarctic mountain landscape at its greatest. The first white man to visit it, the surveyor-general William Ogilvie, reserves his only departure from the matter-of-fact account of his two-year journey through the Yukon and Northwest Territories for this region. Of the prospect north and south from the saddle between Mount King and Mount Deville, he says, "This is one of the grandest views I have ever seen, and the profound stillness and vast solitude impress one as perhaps few other scenes in the world would." Not much has changed there since that day in 1888—a small lake seems to have dried up and the trees must have grown somewhat, but that is about all.

To the beholder, three features above all distinguish the Sheep Mountain country and set it apart at a glance from the regions so far traversed: the castellated escarpments of its uplands, the span and sweep of the valleys, and the relative predominance of open muskeg. In the Boundary Mountains the sculptured rocks seemed merely incidental ornaments, set here and there against the backdrop of ridges and peaks; here they crown the elevations and continue in long colonnades as far as the eye can see. In these uplands, younger and softer rocks form the center of the upfold; they tend to erode below or, at best, level with the subjacent cliff-forming strata. Uplift and folding may also have been more regular and less severe in this region, giving it the large-scale symmetry one observes. Finally, the region was glaciated, whereas the Boundary Mountains were not. The glaciers in question



were merely minor valley glaciers, not extensions of the continental ice sheet, but in deepening and broadening the valleys and clearing them of spurs, the glaciers have left their mark on the topography. In the valleys thus widened and leveled, drainage was slow and muskegs formed, as they tend to do in regions where permafrost is prevalent. In late summer these muskegs turn cinnamon, and together with the deep green ribbons and streamers of forest, the gray talus fans mantling the slopes, and the great battlements towering above, they make this land look like none other.

Near Meeting Lake some very curious rocks occur; whatever one's personal interest in the detailed history of rocks, a trip to Meeting Lake is an experience not easily forgotten. Vivid memories of this part of the country often owe their vividness to the distressing circumstances one had to put up with at the time, but it is unlikely that a trip to Meeting Lake will be remembered for that reason. If you take the right route (up "Flourball Creek"), it is nearly all plain sailing, and the sights you see on the way are truly incredible. Time and again you tell yourself this just can't go on, but it does. It is a walk on which you can learn that peculiar fear that comes with exposure to a degree of beauty, an alien order of magnificence, that leaves you strangely helpless, uncomprehending, and feeling expendable. Having swatted up on your geology won't help you now. But although you don't feel very much "needed," or exactly "master of all you survey," you wish for nothing better than to walk on forever through that land. Even the occasional grizzly track won't make you change your mind. It is part of the land. There is only one thing you truly fear out there: that someone might want to tamper with it. That in some well-appointed, air-conditioned office, plans are being laid to put it to some profitable use.

For its vastness and solitude are only a measure of its frailty. One road is enough to wreck it. With a road another world enters, the loud new world we know so well, and the old order is just an empty, punctured shell, its spirit gone. One can only hope that room can still be found for both. ■

What Do We Learn at the Zoo?

Continued from page 29

This answer is a real shocker to anyone concerned with mental hospitals. Today, additional manorial buildings in isolated areas are being given the lowest priority. Instead, the emphasis is upon small, active treatment hospitals located near population centers; but this lesson cannot be learned from a single field trip to a mental hospital with a largely chronic population.

My use of the mental hospital as a point of comparison with the zoo is not accidental. In a brilliant paper, psychiatrist Henri Ellenberger traces the parallel development of mental hospitals and zoos, from places of public amusement to their present emphasis on humane treatment and public education. The first public mental institution in England, Bethlehem Royal Hospital (later corrupted to Bedlam) was supported by admission fees charged the visitors at the penny gates. Tickets were sold to members of the public who wanted to view the antics of mental patients. The patients would perform in order to receive candy, food, or money.

After the French Revolution, when the French government wanted to develop a model zoo, the Natural History Society of Paris appointed a committee of three men to study the project. One of these was Pinel, who had supervised the dramatic hospital reforms at the Bicêtre Hospital. Pinel was the subject of the dramatic painting of the doctor removing the chains from the legs of a madman. Out of the efforts of Pinel and his committee came the Jardin des Plantes in Paris, a zoo that was intended for public education, and which subsequently became the model for institutions of its kind during the nineteenth century.

It would be a serious mistake to confuse the behavior evident in any prison or mental hospital with the "natural" behavior of criminals or mental patients. Visits to prisons and mental hospitals can tell us something about the effects of confinement and institutional routine and, I am sorry to say, all too often about the progressive brutalization of inmates. In the same manner, a visit to a zoo will reveal a great deal about the adaptation of animals to captivity.

I would never have become aware of this situation had I not questioned my students specifically about the field trip. As far as I can tell, few zookeepers and animal biologists have ever questioned zoo visitors about what they have learned during visits. My own cursory explorations in zoos suggest that too many children are learning about animal behavior from the way animals pace in their cages or sit around watching the visitors.

How should a visitor interpret a convict pacing in his cell, a mental patient screaming in the isolation room, or a lion pacing in his cage? What is one learning about the nature of criminality, about mental illness, or about the behavior of lions? When a person makes a single visit to a novel setting and is bombarded with unusual stimuli, a great deal of his learning will be nonverbal and intuitive. Since his ordinary concepts cannot encompass what the visitor sees, hears, feels, and smells, this nonverbal learning will deal with the particular quirks, peculiarities, and behavioral idiosyncracies of the animals and his subjective reactions to them.

I am not simply complaining about the brutalization of mental patients, prisoners, or zoo animals. My criticisms apply to good mental hospitals, prisons, and zoos, as well as poor ones. We must be clear about the effects they actually produce, as well as their avowed goals.

If we want zoos to be places of public amusement, let us invite back the circus keepers who know how to train animals to do tricks. I do not say this in any disparaging sense. I believe that the public wants, and is willing to pay for, places of public amusement.

If we want research laboratories for animal biologists, that is another matter. I think that this is a very important activity and it should be budgeted as such. The National Institutes of Health have established a number of excellent primate laboratories in various parts of the country, including one on my own campus. Although visitors are welcome on certain days and in certain prescribed areas, no one pretends that public education is a major function of a National Primate Center. For the most part, they are run by, and for, biologists so that they may learn something about the lower primates that may be applied to the improvement of human health.

The animal biologist has sharpened his senses so that he is attuned to every nuance of animal behavior, but this provides no guarantee that he is equally sensitive to the attitudes and behaviors of his own species, particularly children. As a teacher, I know how difficult it is, in a class of 30 or 50 students, to learn what they are thinking. Sometimes I think I have succeeded in getting information across, only to find disastrous misunderstandings when the examinations are turned in.

It is all too easy for the poor teacher to blame his students for their ignorance, for the park ranger to blame inconsiderate campers for a litter problem, or for zoo officials to think in terms of insensitive and unresponsive visitors. People who live or work in a place see things differently than do casual visitors. Hospital nurses and physicians tune out the noise from carts being wheeled down the corridors, the jangling of bells, hospital odors of all varieties, and the vagaries of hospital time, but they are extraordinarily sensitive to messages over the loudspeaker system that seem unintelligible to patients and visitors. Lying on one's back on a hospital bed for several days changes one's view of the world. In a wheelchair or on crutches, distances seem much longer than usual. Nurses and patients, teachers and pupils, and zookeepers and visitors, all inhabit different perceptual worlds.

The question about the proper role of the zoo must concern those who care about wildlife. It is obvious that some people assign a very low priority to the survival of the crocodile or even the bald eagle, our national emblem. We cannot assume that people are born with an enduring interest in wildlife and natural beauty. The human species has been "at war" with nature too long for us to assume that our basic instincts are of a benign or even an altruistic sort. Rather, the task is one of continued public education about the importance of wildlife and the needs of each particular species.

If the zoo is miseducating the public about the behavior of ani-

mals, as I think it often does, then this is a serious matter for all of us. The first task is to learn exactly what people learn when they visit zoos. After that we can decide what aspects of the zoo should be overhauled, strengthened, or eliminated.

It may be that for certain species, a well-run zoo adequately portrays the animal in its natural habitat, for example, a nocturnal rodent seen by the public under red light. But in the cases of large mammals, such as lions and giraffes, it is likely that the educational value of the zoo is minimal or even negative. I would turn these portions of the zoo back into research stations for scientists who are interested in the biology and behavior of captive animals and downgrade the public educational functions.

At the present time, zoos take their research function very seriously and join in the dissemination of information about the care and treatment of captive animals. It would be desirable to devote a small portion of these efforts to studying zoo patrons, particularly young children, and what they have learned from their visits.

The question cannot be framed in a simplistic manner since it must encompass variations in type and mode of exhibit as well as different visitor populations. We can learn something about the proper viewing distance for each species and the placement of cages. We may find that tours for schoolchildren should be run in series and developed in conjunction with appropriate reading and documentary films, rather than be taken singly. A zoo may spend a great deal of money arranging its animals according to place of origin without visitors being aware of this. Many of the signs under the cages are uninformative and arcane. Research into visitor responses can lead to the improved design of zoos to realize their expressed educational objectives.

I do not question the idea that zoos should have a role in public education about animal behavior. Indeed just the opposite is true: I believe that the public education function should be taken seriously enough to subject it to systematic inquiry. We must learn the extent to which the zoo serves to develop a proper environmental ethic. ■

Th

Scratched and Chiseled Marks of Man

by Jerome Y. Lettvin

An overengraved and renewed mare, a bison associated with serpentine images, and two "killed" bears, part of engraved wall composition in the cave of Les Trois Frères, are depicted in this line rendition.

The Roots of Civilization, by Alexander Marshack. *McGraw-Hill Book Co., $17.50; 413 pp., illus.*

Mr. Marshack's book presents a new method in paleology and some of the results obtained from its use. The new method simply brings the apparatus of the police laboratory to bear on mysteries from the remote past. Using a low-power microscope, Marshack examines the scratched and chiseled marks left by ancient man, in the same way that microscopes are used on documents suspected of forgery or on clues left by a criminal. Which marks were made first, which later? How were they made—one after another in a single sitting or separated by long intervals? Can some of the maker's intentions be inferred from the way they were made?

It is a little surprising at first that such a careful study on the graphic methods had not been done before—because the techniques for study have been available for a long time. But then, since nobody expected to find anything, nobody went to look—until Marshack began his work with the assumption that the marks were meaningful and that their meaning could be guessed. For this reason, as well as many others, the book is valuable. It shows that the days of discovery are not yet over and that strong contributions can still be made outside the academy and by self-professed amateurs.

What Marshack found were, principally, lunar calendric notations inscribed along the edges and on the faces of bone fragments. These fragments date from ten to thirty millennia back in time, all the way back to when Cro-Magnon man appeared in Europe, displacing Neanderthal man as the glaciers receded. In most cases the evidence for calendric marking is compelling. Sometimes the marks are grouped in reasonably distinct periods corresponding to the number of days between distinct phase changes of the moon. Sometimes the overriding periodicity of the marks is that of the whole lunar cycle. There is enough evidence marshaled to make a perfectly lovely case. Marshack, however, seemingly a bit nervous about his forwardness in scientific matters, indulges in a kind of overkill. There are too many diagrams fitting the data to cycles, and they are often harder to make out than had he simply sketched a looser fit. I can sympathize with his eagerness to make the best possible case, but it just isn't necessary to hammer the points that much and with such complex figures on the basis that some learned skeptic will otherwise call the work unscientific. I can imagine a future scholar taking a decoder to Marshack's notation.

Marshack makes an excellent case for calendric marking and for the extreme intelligence of modern man when he first appears as Cro-Magnon. But some of the text obscures this message. There are certain words and phrases that sound like the Harvard School of Education trying to be serious. I imagine "cognitive" once had a meaning before educators began using it, and "time-factoring" will almost certainly have a fad if it isn't currently being used by them. The trouble with such words is that they usually displace thinking. I know that Marshack, unlike those who usually use such words, meant to discuss the significance of what he had found. But I wish he had put his thoughts in less scientific-sounding language, for at times I could not grasp what he was trying to say.

Except for a chapter or so in this odd jargon and an occasional word-picture of what an advanced troglodyte standing at the mouth of his cave might have felt, the text makes interesting and pleasant reading. It

is presented, properly, as a personal adventure—and Marshack writes with justified pride. He has gone to some pains to collect references and mixes his scholarship with his adventure in an engaging way. And he has made a real and important discovery.

So far I have reviewed the book explicitly, as it stands, and as the publishers meant it to be taken. Were that all, I would end here. But the volume has given me several sleepless nights. Marshack has illustrated the work profusely, and these photographs and sketches raise questions, hinted at in the text, that he refuses to develop because he is cautious. To elaborate on these questions would take a lengthy, independent paper, but I would like to indicate a few here.

If the markings are calendric, as they seem to be, then certainly, they must have been read, if only by the mark-maker himself. The wearing on the bones shows, as Marshack remarks, that they were carried around or were much handled. How were they read? They need not have been counted, certainly. Marshack thinks they weren't. Then the phase transitions in the marking sequence must have been noted and read. But why read phase transitions on bone when one can glance at the moon? Well, as Marshack suggests, to prepare for a ritual, a ritual such as a hunt. But to prepare means to be able to read that a phase transition is, say, tomorrow. Virgins have to be ready, the healthy buffalo selected—all the busy routine that so occupies one on the days before an Event. See what that image implies? It tells us that the position in the phase is to be known by the marks, and yet the marks for a lunar phase are all alike—otherwise Marshack could not have read them as calendric so successfully. And, in turn, that would mean that the mark-maker could count—if only by setting mark against day, by matching the two sets.

So one looks at "The Bone of the Eagle" (chapter 10) and dreams. Marshack thinks that all complex marks of the same sort, involving at least two strokes, were made at one session—all of one kind of stroke first; all of the other kind of stroke after. The reason he believes this is that each mark is like its neighbor in the series of marks, although he makes the telling point that the two strokes in a mark are made by different instruments. He is reluctant to propose what he hints at, but

Line rendition of engraved rhinoceros on La Colombière pebble (*ca.* 20,000 B.C.) indicates original drawing of the head and subsequent overengraving as determined by microscopic analysis.

then practically denies: that each vertical mark could have been made on a separate day, and each foot added after, at the corresponding part of a later lunar phase. I asked him about this, and what he said was that the marks were all so similar that experts assured him they must have been made in a single session. Alex, Alex, look at the hand that carved those wonderful lions and horses and fish, and then say if that artist's sureness could not have done in leisured sequence what your "experts" say must have been done in one Stakhanovite session.

And now another ghost comes to sit by the bed. Marshack shows, or suggests, that notation diffused as early modern man—that papa of all present races—diffused. And so with him must have diffused the sounds he made. One looks at the conservatism in evolution—one small step at a time, and the change must be consistent with what has not changed. So the vertebrate plan is preserved from fish to man—waste not, want not. One looks at conservatism also in the evolution of man's artifacts (automobiles are good examples—where economics determine that every year only a few parts can change and the changes must be compatible with what doesn't change).

I mention these matters because the glimpse of early man in this book raises such questions and dreams. And that is what a book ought to do. Certainly I realize that there are defects in Marshack's style; that he is cautious when he ought to be bold, obscure when he should be clear, and pads when he should be concise. But these defects are beside the point. What is more important is that some of his notions and some of his arrayed pictures set one to playing Sherlock Holmes, Tarzan, and Leonardo in fantasy. It is more a book for the young, who are still curious, than for the old, who are overcritical and have forgotten how it feels to guess at what words can ill encompass. I liked it, even when I was most exasperated with it.

Dr. Jerome Y. Lettvin is professor of communications physiology and a lecturer in the Department of Humanities at the Massachusetts Institute of Technology.

More Reviews

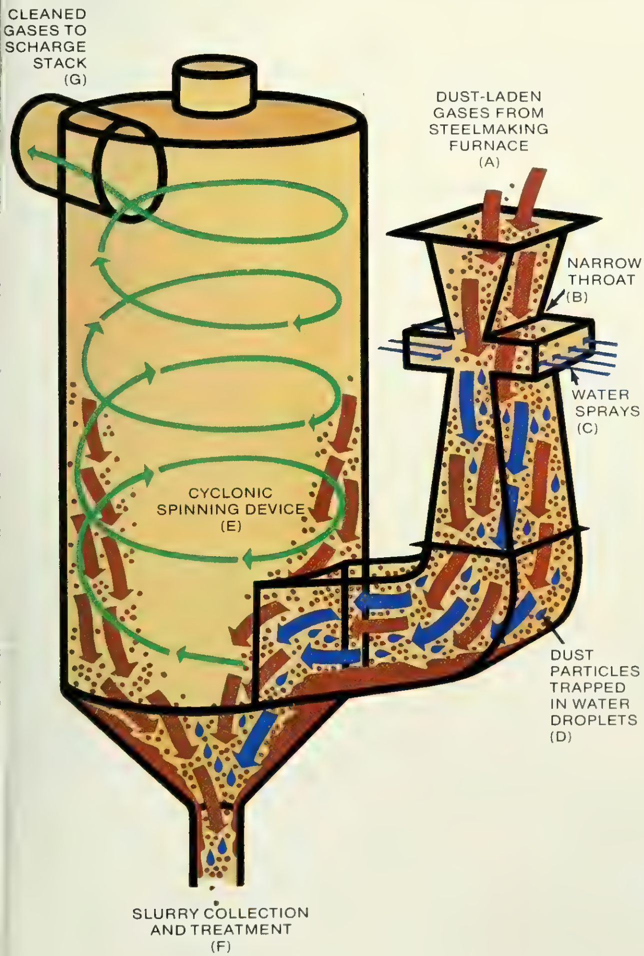
The Restless Earth, by Nigel Calder. *The Viking Press, $10.00; 152 pp., illus.*

Those who were fortunate enough earlier this year to have watched a two-hour BBC television documentary entitled "The Restless Earth" hailed the show as geology's first TV "spectacular." The publication of a book on the same topic by the same writer will open the door to a far wider public and will be welcomed by the original viewers, who now have the opportunity to dip more leisurely into some of those fascinating, almost subliminal concepts they glimpsed in the few seconds' exposure on the television screen. The diagrams and graphs are all here, and the color pictures are absolutely glorious.

Geology today is undergoing as profound a revolution as biology did in the last decade, but it does not mean that the rock men are burning their boots and throwing away their hammers in favor of the "black boxes" of geophysics and geochemistry. Far from it: the demand for more field work, more exploration, more mountain climbing, more ocean-floor probing is greater than ever. But we are not looking aimlessly. We now have a globally encompassing theory that cries out to be confirmed and expanded.

Nigel Calder is that very rare species, a science writer—he is editor of the *New Scientist*—who can actually write and who also has the mental capacity to attend meetings, read the literature, and find out what is really going on. His action in bringing out the complex ideas and discoveries of the new geology, in language that everyone can follow, deserves our warmhearted approval. He takes in a breathtaking sweep of concepts—the lines of earthquake epicenters, which define the fractured "plate" of the earth's crust; Wegener's jigsaw puzzle, fitting the continents together; the rotation of Spain; the Italian boot kicking back into Yugoslavia and pushing up the Alps—all the bits that are beginning to fall into place.

How we send our dust to the showers



Many of our steelmaking operations generate a lot of dust. A "wet scrubber" is one of the systems that keeps our dust and fumes from escaping to pollute the environment.

In a typical example, dust-laden gases from a steelmaking furnace (A) are directed by a narrow throat (B) through water sprays (C). The fine particles of iron-oxide dust are trapped in the water droplets (D).

In a "demisting" process which follows, the dirty wash water passes through a spinning device called a cyclone (E). Droplets of polluted water are spun centrifugally by the whirling current to the sidewalls. The contaminated droplets run down the walls and are discharged in the form of a slurry. The slurry is further treated (F). Cleaned gases are discharged through a stack (G).

This combination of scrubber and cyclone collects better than 99 per cent of the fine particles discharged from steelmaking furnaces. It all adds up to hundreds of tons of dust daily . . . dust which is captured, not released into the atmosphere.

Our employees and their families all breathe the same air, drink the same water. Since we are our own neighbors, we want to be good neighbors.

BETHLEHEM STEEL

BETHLEHEM STEEL

But continental drift is not a one-shot affair. The "magnetic striping" uncovered in the ocean floor gives us a stratigraphic record, confirmed by the deep-sea drilling program of the *Glomar Challenger*, that takes the story back nearly 200 million years. Shortsighted scientists thought that that was all there was to it. Now, newer ways are being worked out for discovering even more ancient plate boundaries. One of these was pioneered fifty years ago by the great Alpine geologist Gustav Steinmann. Students of geosynclinal history had heard of "Steinmann's trinity," a certain combination of three rocks that was evidence of a former continental margin. This combination included ultrabasic rocks (dense lavas that erupted on the sea floor or were injected into the nearby crust); cherts or flints (evidence of free silica liberated by the submarine eruptions); and flysch- or graywacke-type sediments (which proved a deep-sea trough).

So thus it is that the boots-and-hammer geologists can identify sites of former cycles of continental drift and plate collisions. And that is not all. As Nigel Calder has developed his theme, there is a bonus. When plates collide, one must override the other. The descending plate melts and generates molten rock with concentrated chemical elements from the former sea floor. Veins are emplaced containing the much sought-after metals: copper, lead, zinc, silver, gold.

This reviewer, who is also a professional scientist, rarely approves of a popularization. Far too often the science writer is naïve and uncritical. Calder, however, seems to remain calm and judicious and expresses the story warmly yet fairly. He names names, indexes the work, and you can check him. It checks out.

RHODES FAIRBRIDGE
Columbia University

THE HUMAN IMPERATIVE, by Alexander Alland, Jr. *Columbia University Press, $8.50; 185 pp.*

It was Voltaire who remarked that God created man in his own image, and man has returned the compliment. Unable to face the crippled image of himself and the devastation he has wrought in the


For four generations
we've been making medicines
as if people's lives depended on them.
Lilly

world, he has resorted to the scapegoating device of blaming it all on Nature. It is not we, but Nature that is responsible for our aggression and destructiveness. We are "programmed," "biogrammed," "wired," for aggression and violence, and do what we will, these are part of our nature. There are experts (an expert being defined as one who *should* know) who can point to parts of the brain and tell you that there is where all the trouble lies. And what more proof of the innate orneriness of man does one need than that?

The new biological reductionism has not only enlisted the support of many neuroscientists, but even more surprisingly, of quite a number of behavioral scientists as well. It will take years to set the record straight, but meanwhile, such popular writers as Lorenz, Ardrey, Morris, and others are enjoying, to coin a phrase, a regular field day. It is to the views of these writers that Professor Alland addresses himself.

As an anthropologist, Alland is able to bring a perspective to bear upon the behavioral traits of human beings that is entirely lacking in "LAM" (Lorenz, Ardrey, and Morris). Man is behaviorally polypotential—he is capable of anything within his individual genetic limits, but he is not predetermined to be anything in particular. What he becomes, he learns on the basis of potentialities that are biological and influences that are social. His heredity is not what he is biologically endowed with at conception or what he is born with, but the expression of the interaction between his genetic potentialities and the environmental influences that have acted upon them.

As Professor Alland shows, environmental factors, which in man are largely cultural, have a way of producing behaviors that the unsophisticated readily attribute to innate factors. But these behaviors are, in fact, largely or entirely learned. In the matter of aggression, Alland is able to demonstrate this from studies by anthropologists in the field, including one of his own. The biological determinists completely fail to understand the role that culture has come to play in the development of human behavior, and they fail to do so because either they lack knowledge or else

they have a warped and wholly erroneous understanding of the peculiar nature of man's evolutionary history.

There seem to be other motive forces at work in the rather Hobbesian view they take of the nature of human nature. At any rate, the writings of LAM have great appeal for corporation presidents, racists, and inhabitants of the Pentagon, a fact that elicits appropriate comments from Professor Alland. Unfortunately, Lamian writings also have a profound and widespread appeal for the general reader, since Lamianism offers a simple and easily understood explanation of the ills of mankind. It also offers absolution for the sin of being ornery. All of which may be gratifying to the "true believer," but it is hardly science. What is worse, Lamianism, as Alland points out, diverts attention from the real causes of human aggression and violence by focusing on purely spurious ones. Professor Alland's book will help to keep the focus where it should be—with those who are attempting to discover the truth, not with those who claim to have found it.

Ashley Montagu

Briefly Noted:

Touch the Earth: A Self-Portrait of Indian Existence, compiled by T.C. McLuhan. *Outerbridge & Dienstfrey, $6.95; 185 pp., illus.*

T.C. McLuhan has allowed the Indian to speak in his own voice by presenting speeches and writings that follow the dismal course of North American history. The years of broken treaties and promises have evoked an eloquent response of surprise, anger, humiliation, and hopelessness, and these selections recount "the pain of the Indian as he experienced the death of his way of life." The book is illustrated with photographs of Indians taken in the early years of this century.

American Indian Portraits from the Wanamaker Expedition of 1913, chosen and with an introduction by Charles R. Reynolds, Jr. *The Stephen Greene Press, $12.50; 124 pp., illus.*

Three mainly photographic expeditions to the American Indian (1908, 1909, 1913) were launched

by Rodman Wanamaker (son of the department store family) and resulted in thousands of still pictures and fifty miles of movies. In 1965, a picture researcher for *Infinity* magazine discovered these remarkable Indian portraits filed and forgotten in a drawer at The American Museum of Natural History. Believed to be the result of the last expedition, precious little information exists concerning the pictures—even the identity of the photographer is in doubt. Wanamaker financed the expedition to dramatize the plight of the Indians, and the 120 portraits represent a highly personal and romantic viewpoint of a vast selection of cultural groups from across the country.

New York Walk Book by New York-New Jersey Trail Conference and The American Geographical Society. *Doubleday/Natural History Press, $9.95; 326 pp., illus.*

First published in 1923, this fourth edition of *New York Walk Book* is written proof that areas of great natural beauty are available to New Yorkers willing to use their feet. Wilderness trails within fifty to one hundred miles of the city, easily reached by car or bus, are sketched for the would-be hiker. Areas included range from Van Cortlandt Park, Queens, and Staten Island, to Long Island, New Jersey, Bear Mountain, the Catskills, Connecticut, and the Hudson Highlands. Tips for beginning hikers are given, plus information on the difficulty of the proposed hike, the amount of time needed, and what to see along the way.

C.B.

The American Museum is open to the public every day during the year, except Thanksgiving and Christmas. Your support through membership and contributions helps make this possible. The Museum is equally in need of support for its work in the fields of research, education, and exhibition.

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12—C. Brian Burke
14—Steve Myers
16—AMNH after Hirst
18—Barbara Hollingsworth
25—Steve Myers
31-38—Courtesy of China Pictorial, Peking
41—Leonard Lee Rue III, National Audubon Society
43-45—Dale F. Lott
46—Steve Myers
49-53—H. Peter Loewer
54-63—James E. Harris and Kent R. Weeks
64-70—Paul von Baich
72—Frank Drake, and Carl and Linda Sagan, Cornell University
74-75—Helmut Wimmer
82—AMNH
86-88—Courtesy of McGraw-Hill Book Co.

Suggested Additional Reading

IN PRAISE OF BIKERS, HIKERS, AND CROWDED CARS

THE ENERGY RESOURCES OF THE EARTH. M.K. Hubbert. *Scientific American*, September, 1971.

THE CONVERSION OF ENERGY. C.M. Summers. *Scientific American*, September,1971.

HISTORICAL PERSPECTIVE IN TRANSPORT SYSTEM DEVELOPMENT. R.A. Rice. Chapter 9 of ADVANCED URBAN TRANSPORTATION SYSTEMS. M.A. Williamson, ed. Transportation Research Institute, Carnegie-Mellon University, Pittsburgh, 1970.

WHAT DO WE LEARN AT THE ZOO?

WILD ANIMALS IN CAPTIVITY. H. Hediger. Dover Publications, Inc., New York, 1950.

MAN AND ANIMAL IN THE ZOO. H. Hediger. Delacorte Press, New York, 1969.

TEACHING FOR SURVIVAL. M. Terry. Ballantine Books, Inc., New York, 1971.

THE NEW ARCHEOLOGY OF CHINA

PREHISTORIC CHINA. T.K. Cheng. W. Heffer & Sons Ltd., Cambridge, 1966.

NEW LIGHT ON PREHISTORIC CHINA. T.K. Cheng. W. Heffer & Sons Ltd., Cambridge, 1966.

ARCHAEOLOGY OF ANCIENT CHINA. K.C. Chang. Yale University Press, New Haven, 1968.

ARCHAEOLOGY IN CHINA. W. Watson. University of London Press, Ltd., London, 1960.

BISON WOULD RATHER BREED THAN FIGHT

ANIMAL BEHAVIOR. N. Tinbergen. Time-Life Books, New York, 1965.

THE TIME OF THE BUFFALO. T. McHugh. Alfred A. Knopf, Inc., New York, in press.

ETHOLOGY OF MAMMALS. R.F. Ewer. Plenum Publishing Corporation, New York, 1968.

CONCEPTION AND CONTRACEPTION

PHYSIOLOGY OF REPRODUCTION. W.D. Odell and D.L. Moyer. The C.V. Mosby Co., St. Louis, 1971.

TEXTBOOK OF CONTRACEPTIVE PRACTICE. J. Peel and D. Potts. Cambridge University Press, New York, 1969.

FERTILITY AND CONTRACEPTION IN THE HUMAN FEMALE. J.A. Loraine and E.T. Bell. The Williams & Wilkins Co., Baltimore, 1968.

THE HORMONES IN REPRODUCTION. C.W. Corner. Atheneum Publishers, New York, 1963.

X-RAYING THE PHARAOHS

AKHENATEN, PHARAOH OF EGYPT. C. Aldred. McGraw-Hill Book Company, New York, 1969.

CULTURE OF ANCIENT EGYPT. J.A. Wilson. University of Chicago Press, Chicago, 1951.

ANCIENT KINGDOMS OF THE NILE. W.A. Fairservis, Jr. Thomas Y. Crowell Company, New York, 1962.

NATURAL HISTORY

OCTOBER 1972 • $1.00

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NATURAL HISTORY

THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY   INCORPORATING NATURE MAGAZINE

The American Museum of Natural History

Gardner D. Stout, President   *Thomas D. Nicholson, Director*

Vol. LXXXI, No. 8   October 1972

COVER: *A bobcat and her two dependent kittens warily survey their surroundings. When about nine months old, the young will leave their den and wander as far as 100 miles to find their own territories.*

Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Published monthly, October through May; bimonthly June to September. Subscriptions, $8.00 a year. In Canada and all other countries $9.00 a year. Single copies $1.00. Second-class postage paid at New York, N.Y., and at additional offices.

Authors

As a research associate with the University of Paraná in Brazil, and as an independent investigator, **Vladimír Kozák** has made numerous ethnographical field trips into the Brazilian interior. He was a member of the first scientific expedition to visit the Héta Indians at their forest encampments. His

Vladimír Kozák

recording of the making of a Héta stone ax is the only documentation of its kind. Kozák, who was born in Czechoslovakia, emigrated to Brazil to work as a mechanical engineer. Since his retirement more than 20 years ago, he has devoted much of his time to filming and painting South American Indians.

Doing the research for a history of oceanography can be a time-consuming project, especially when the author, **Susan Schlee**, tracks down the incidental, yet significant, information to be found in the accounts of marine scientists. In this issue, she relates the saga of the Antarctic voyages of the *Erebus* and *Terror* in 1839, and of the rare 6¼-inch fish "caught" by one of the ships. Schlee, whose oceanographic history, *The Edge of an Unfamiliar World*, will be published in January

Susan Schlee

by E.P. Dutton & Co., works out of the Marine Biological Laboratories at Woods Hole.

Naomi Gilpatrick first became interested in Beatrix Potter when she was teaching reading to elementary school children. The college courses she has given on children's

Naomi Gilpatrick

literature prompted her to delve further into the early scientific career of the creator of some of the world's most enduring children's stories. Gilpatrick's own literary works include a novel, *The Broken Pitcher*, numerous magazine articles, poetry, and a play. Presently an assistant professor of education at Paterson State College, she has also been a drama critic and newspaper book editor.

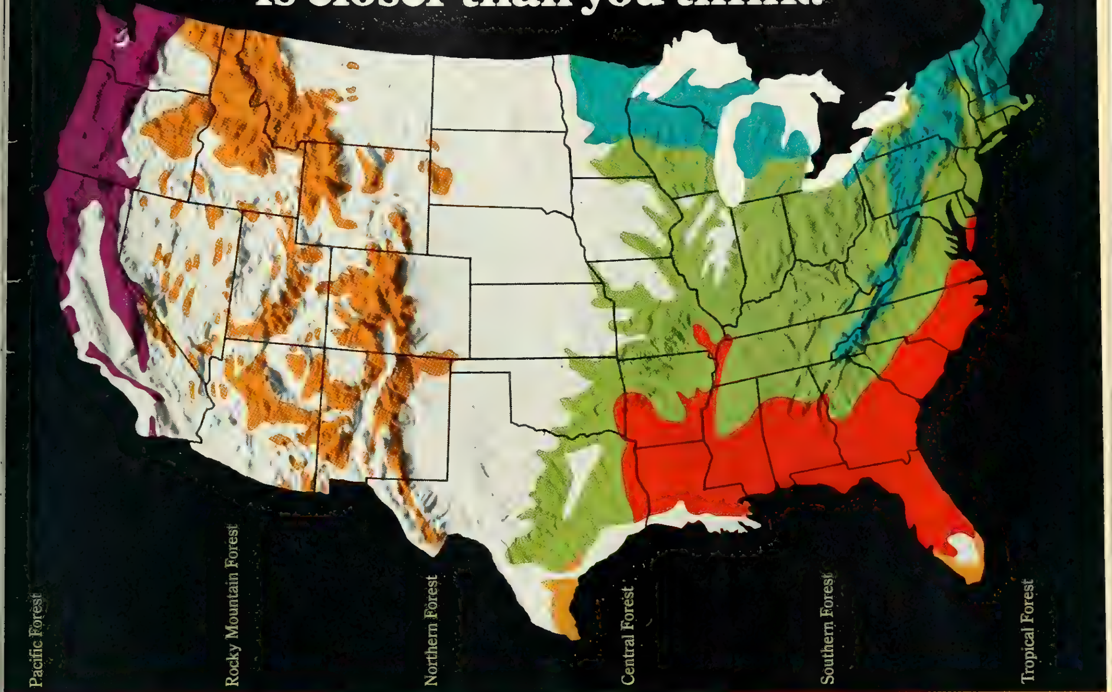
For **Ann Zwinger**, freelance writer and artist, accessibility to the alpine tundra is one of the enjoyable features of living in Colorado Springs. She has made many trips into the Rockies, and frequently flies over them in her husband's

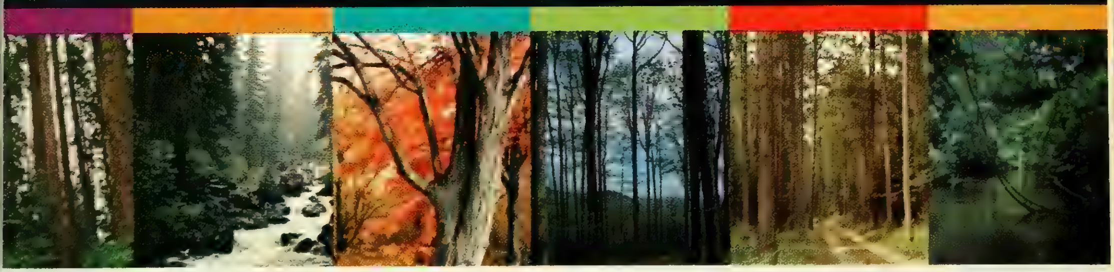
Ann Zwinger

plane. When not climbing mountains or writing about them, Zwinger does collages and pen-and-ink drawings. She is the author of *Beyond the Aspen Grove*, published by Random House.

Beatrice E. Willard, who collaborated with Zwinger on "Above the Treeline," is a vice-president of

The great American forest is closer than you think.





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the Thorne Ecological Foundation of Colorado. She has conducted extensive research into the effects of visitors on alpine tundra ecosystems. Willard is a former research

Beatrice Willard

assistant at the Institute of Arctic and Alpine Research of the University of Colorado, and founder and director of Seminars on Ecology at Rocky Mountain National Park. The article is adapted from *Land above the Trees,* to be published next month by Harper & Row.

When **Theodore N. Bailey** began to study the bobcat, little was known about the feeding habits, habitat, and social behavior of this solitary animal. His observations, conducted over a three-year period in a 250-square-mile area of southeastern Idaho, have led to a new understanding of prey dependency,

Theodore N. Bailey

territoriality, and reproduction in this widespread predator. As part of his interest in the behavior and ecology of carnivores, Bailey has also studied predation in the striped skunk. He is a research associate with the Idaho Cooperative Wildlife Research Unit of the University of Idaho.

One of the reasons **John Goss-Custard** selected the redshank for his doctoral studies was that it is a common shorebird and, he thought, easy to study. But when he delved into the bird's behavior—spending months watching it, particularly during the winter in northern Scotland—he found that the life strategy of this small bird is complex and fascinating. Goss-Custard is associated with the Department of Psychology of the University of Bristol, England, where he is continuing a series of experiments on the feeding behavior of the redshank.

Intrigued by the Minoan language, and resolved to decipher it, **Cyrus H. Gordon** made his first trip to Crete in 1931. After service as a military cryptanalyst of enemy codes and ciphers during World War II, he conducted seven more expeditions to the island. His grasp of the Minoan language and culture

Cyrus H. Gordon

enables him to identify many links between the ancient Mediterranean civilizations. Last year Gordon, whose prime research interest now is underwater archeology, worked on the excavations of King Solomon's seaport at Ezion-geber on the Gulf of Aqaba. He is a professor and chairman of the Department of Mediterranean Studies at Brandeis University.

It is two million years ago. On an African savanna, a strange creature browse for food. He looks something like an ape and also like a man. He walks upright — yet h forehead is flat, his jaw thrusts forward. He doesn't know it — but he represents a gian step forward in evolution. For he is the "missing link" between ape and man . .

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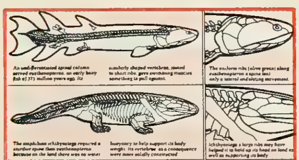

Color-keyed charts like this make the evolutionary processes easy to understand.

Today, that creature who first ventured to raise himself above the other animals no longer exists; he has become you. Unique. Set apart from the 2 million other species living on the planet by a thumb that makes your hand a precision tool . . . by a knee that "locks" you in a comfortable upright position . . . and by your capacity for abstract thought and speech. All this, and more, has enabled your species to dominate the earth. And yet you share, with every other creature that ever lived, the same origins — the same accident that led to the spontaneous creation of the first single-celled algae 3.5 billion years ago.

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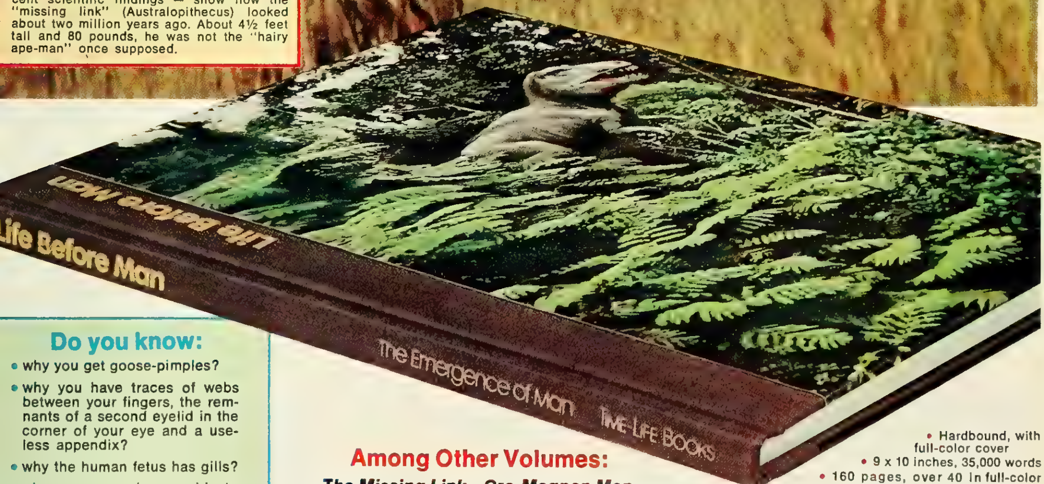

Do you know:

- why you get goose-pimples?
- why you have traces of webs between your fingers, the remnants of a second eyelid in the corner of your eye and a useless appendix?
- why the human fetus has gills?
- why some people are able to wiggle their ears?
- in what way Neanderthal Man was "religious"?
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Letters

The Predatory Dragon

Readers of your magazine might like to know that the first scientific expedition to the island of Komodo, which I led, was undertaken by The American Museum of Natural History in 1926. In our report the following year about the so-called Komodo dragon, we declared that the giant lizard was a true predator. This conclusion was later disputed, so I am pleased to find out that Dr. Walter Auffenberg, after his extensive studies on the island, has confirmed our original conclusion in "Komodo Dragons" [April, 1972].

The fossil remains of the great prehistoric varanids of Australia, known to be contemporaries of early man, suggest that these animals were able to walk off with a man in their jaws as easily as the Komodo lizard does with a monkey. My original suggestion that these early relatives of the Komodo monitor could well have given rise to the dragon stories that circled the world was founded on this possibility. Indeed, the entire dragon mythology could well have been based on fact, namely, on the enormous saurians that evidently lived side by side with Pleistocene man in Australia.

Since *Varanus komodoensis* is undoubtedly an endangered species, it is to be hoped that Auffenberg's observations will contribute to its long-term survival.

W. Douglas Burden
Charlotte, Vermont

Beaver Corps

I have just finished reading "Return of the Beaver," by John W. Miller (June-July, 1972), and found it to be most interesting as well as educational. It would be fitting and proper for the Army Corps of Engineers to be replaced by the Beaver Corps of Engineers.

Jane Suppona
Palmdale, California

Watching The Strippers

E. F. Roberts's review of Harry M. Caudill's book *My Land Is Dying* [June-July, 1972] asserts that "TVA . . . exhausted its supply of water power and, hell-bent on its mission of providing electricity at a profit to the public, went in search of coal." Two points should be made.

First, the TVA power system operates on essentially a nonprofit basis—the law requires it to be financially self-supporting and self-liquidating, so it maintains a small operating margin.

Second, TVA began using large amounts of coal in the 1950s, which coincided with the Korean war when nuclear weapons facilities were being built for national defense. A large share of them were built in and near the Tennessee Valley and operated on TVA electricity. Thus, TVA's massive coal buying was dictated by national necessity. Moreover, TVA's increased coal purchases came when markets for coal for home heating and railroad operation were declining, and TVA buying did much to alleviate unemployment in the coal fields.

I am particularly concerned with the statement that "TVA, once a liberal dream, continues to make a profit by not coercing its suppliers to behave better." Since 1965, TVA, which has no regulatory authority, has included provisions in its strip mine contracts requiring the operators to reclaim land strip mined for TVA. The provisions are enforced by frequent inspections. They have been strengthened as experience warranted. Yet in seven years, to the best of our knowledge, TVA is still the only major buyer of coal that undertakes enforced reclamation. The irony is that so-called conservation groups have not lifted their voices to support TVA in this practice or to widen its use.

Paul L. Evans
Tennessee Valley Authority
Knoxville, Tennessee

One Man's Meat . . .

I was shocked and repelled to see the three blowsy, unkempt specimens polluting your June-July cover.

Mrs. John Ekern Ott
Hinsdale, Illinois

Thank you very much for the warm, loving, and human cover on your June-July issue.

Paul A. Marsh
Olympia, Washington

Wild Dogs

Nancy Weddell's letter in the June-July issue raised a good question about why man views the Cape hunting dog (*Lycaon pictus*) with such dreadful contempt.

I have spent some time studying the Cape hunting dogs in Ngorongoro Conservation Area, Tanzania, and I can recall my shock the first time I saw a pack make a kill. Although I "knew" what to expect, I was awed by the incredible efficiency and ruthlessness with which the wild dogs caught and disemboweled their prey. Often I saw their teeth slash open a gazelle's abdominal wall and the intestines tumble out. The only consolation I felt in the apparent cruelty was that the prey was obviously in very deep shock and possibly oblivious to pain as it watched itself being eaten.

Generations of European hunters and settlers in Africa undoubtedly witnessed these hunts many times, but understood little else about the Cape hunting dog. Famous hunter-naturalists, such as Selous, Percival, and Vaughan-Kirby, first described the Cape hunting dog's predatory behavior, and later authors expanded this description to create the notorious image of destructiveness that survives to some extent today. Wild dogs were viewed primarily as vermin because almost nothing was known of their social behavior and of their role in the ecosystem. Man saw the wild dog only as a killer, and was unable to place it in a proper ecological perspective.

Wild dogs were shot in African national parks from the turn of the century to as recently as 1958 in Rhodesia. Now their esthetic and biological values are becoming more appreciated, and the wild dogs presently receive adequate protection in most national parks and game reserves. Old attitudes die slowly, but I believe that recent research has created a better appreciation and understanding of the Cape hunting dog that can only diminish man's hatred for this interesting creature.

George W. Frame
Cooperative Wildlife Research Unit
Utah State University

Why Were Bankers Warned That This "New Book Could Upset the Savings Applecart"*

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This is one of the great social tragedies of our time. It means that if you are thrifty and prudent in this country today, you are penalized. Either you are driven to speculate in the stock market, where you can be wiped out overnight. Or you try to secure safety for your hard-earned capital in a bank—*and watch inflation turn your dreams of early retirement and financial independence into dust!*

2. *But you just don't have to accept these two tragic choices any longer!* Now there is a Third Way to invest your money, that gives you the absolute safety you want, plus huge guaranteed returns that you may not even have dreamed possible before.

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NEW BOOK COULD UPSET THE SAVINGS APPLECART

TIGHT MONEY, Regulation Q, and the much-touted Age of the Consumer, are key ingredients in a flammable mixture about to be ignited by a book which could explode in the face of the commercial banking industry this year. This says:

"The millions of people who have saved a few dollars in the form of savings accounts and insurance have been prevented from gaining any profit from their investment—indeed they have been forced to accept real losses—by what amounts to government agency fiat. These depositors have contributed more, perhaps, to the growth of our economy than any other group, and it is unjust that controls apply only to interest rates to depositors, while there are no controls over the inflationary wage and price increases. Conditions permitting this 20 years of discrimination should be changed."

I am quoting from a book, titled, "Don't Bank On It! How To Make Up to 13½ percent and More on Your Savings—All Fully Insured."

The book is dedicated "to the members of the median income group, those truly forgotten men whose savings deposits make banking, as we know it, possible."

"Don't Bank On It" may be coming out at an auspicious time, as the general public is becoming more aware of high interest rates, and, thanks to truth in lending, is being conditioned to look at rates of 12 or 18 percent as low. No doubt he'll soon recognize that 4 or 5 percent is peanuts.

**Bank Marketing Management, Feb., 1970.*

About the Authors

Martin J. Meyer is president of the National Depositors Cooperative Association. He also serves as Vice President and Secretary of Intercept Tele-Communications, Inc., a new international cable and telegraphic interception and forwarding organization. Mr. Meyer has written numerous magazine articles on banking, thrift, and inflation.

Dr. Joseph McDaniel, Jr. was secretary of the Ford Foundation from 1953 until his retirement in 1967 and Dean of the School of Commerce at Northwestern University. His distinguished career includes President of World Health Foundation (U.S.A.) and government service with the Economic Cooperative Assn.

3. It is based on one simple fact: That most depositors are *completely passive* about where and how they save their money! They never take the one or two hours that are necessary to learn the "inside workings" of the banking system. Therefore, they never even hear about the "super-savings-accounts" that can yield them *far more* than ordinary interest on their money.

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How to make banks pay interest to you *on money you don't really even have on deposit—on non-existent money—on money you have already spent!* (And the bank loves you for it. Because, no matter how much you make, they make more! Page 143 shows you how.)

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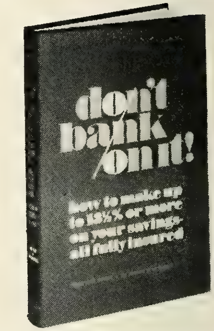

Special Warning Section: Two common mistakes, that unknowingly trap thousands of depositors every year, *that could completely destroy your savings!*

And how to defer income tax on the interest you get. Two plans that offer marvelous tax-sheltered advantages.

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Stone Age Revisited

In a Brazilian jungle, an ethnographer observes and for the first time records in detail the making of a basic tool of primitive life

by Vladimír Kozák

A great deal is known of how primitive man chipped his flint tools. Some anthropologists have seen chipping at first hand, and a few have even become expert at it themselves. But the making of a stone ax, which involves the very different techniques of pecking, grinding, and polishing, has seldom been seen by Western observers. The shaping of a stone ax is so laborious that when steel axes are introduced the practice is abandoned almost immediately.

Only in New Guinea and Amazonia have peoples survived who, within the last decade or two, have actually made and used stone axes. One such tribe is the Héta of southern Brazil. Vladimír Kozák, a member of the first scientific expedition to contact the Héta and the leading student of their culture, had the rare chance to observe them making a stone ax. His article is a unique document in the study of American Indian stone technology.

ROBERT L. CARNEIRO
Curator, South American Ethnology
The American Museum

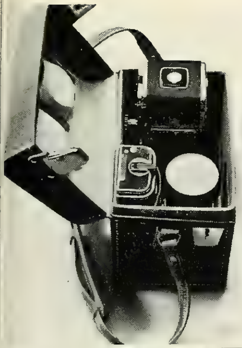
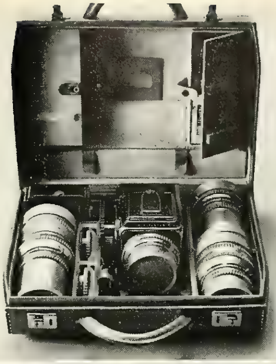
When Europeans first entered Amazonia early in the 1500s probably every Indian tribe in the basin was familiar with the stone ax. Over the centuries since then, a few travelers have left sketchy descriptions of how the stone ax was used, but as far as I know, not one of them ever recorded in detail just how a stone ax was made.

Today the stone ax has all but disappeared from Amazonia, and the chances of recording its manufacture are almost nil. But by a stroke of great luck, in 1960 I had the opportunity to observe the making of a stone ax among the newly discovered Héta Indians of Brazil and to record the event in notes and on film. As it was, the chance came almost too late, for today Héta culture is extinct, and of those Héta who grew to adulthood in the forest, only two are still living.

The Héta Indians inhabited a hilly, heavily forested region of southern Brazil known as the Serra dos Dourados, which until the end of World War II was a forest preserve. Although the region is less than 400 miles from the great metropolis of São Paulo, the tribe was all but unknown. After the war, the State of Paraná, in an effort to promote settlement in the area, began to sell tracts of forest land to private individuals. As surveyors and colonists penetrated the forest, vague reports began to filter out that unknown Indians were living there. Prompted by these reports, in 1945 and 1949 the Indian Protective Service sent expeditions to attempt to locate them. The latter expedition managed to find some ten campsites, but gave up the search before encountering any live Indians.

Then in 1952 a young Brazilian by the name of Antônio Lustosa de Freitas began clearing a patch of forest in the Serra, not far from the Ivaí River. For two years, as he gradually enlarged his clearing, Héta Indians came, unseen, to the edge of the forest to watch him at his work. What particularly caught their eye was the steel ax Freitas used. On occasion, when he happened to leave the implement in the forest overnight, they were able to examine it at close range and to marvel appreciatively at the sharpness of its cutting edge. Never once though did Freitas suspect that there were Indians in the forest.

Eager to have steel axes of their own, the Héta summoned up their courage and on December 8, 1954,


appeared at Freitas's cabin. But Freitas, convinced that he was being attacked, tried to scare them off by beating on the door jamb with the flat of his machete. Actually, their intentions were peaceful, and they had left their bows and arrows behind in the forest.

When calm was finally established, Freitas's wife offered the Indians some sugar and boiled rice, but such food was unfamiliar to them and they spilled it on the ground. After being shown that it was food, and especially after discovering that sugar was sweeter than anything they had ever tasted, the Indians retrieved every bit of it.

Other visits followed, all of them peaceful, and on each occasion Freitas and his family shared their food with the Héta. As the visits continued, however, Freitas, concerned at the extra drain on his meager food supply, decided to notify the Indian Service of the situation.

During 1955 the Indian Service sent three expeditions to try to contact the Héta, and the second one, of which I was a member, encountered a number of them at Freitas's farm. Then in February, 1956, a fourth expedition was organized, this time by the University of Paraná in Curitiba. This expedition, of which I was also a member, succeeded, for the first time ever, in locating and observing the Héta in their own encampments deep within the forest.

We found the Héta to be an exceedingly simple people, living in tiny nomadic bands and subsisting entirely by hunting, gathering, and a little fishing. They did not cultivate plants, nor did they make pottery, weave hammocks, or make canoes. Indeed, they were as primitive a group of Indians as I knew of in all of South America.

At the time of our first contact with them, there were somewhat more than 150 Héta altogether, living in a number of separate bands. "Héta" (sometimes incorrectly written "Xetá") was their name for themselves, and meant "all of us" or "we all."

The camp we visited consisted of seven people, four adults and three children. In Héta camps each family would build itself a simple beehive-shaped hut of poles thatched with palm leaves, but these shelters were used only when it rained. In good weather the Héta moved their palm leaf mats outdoors and slept on open ground under the stars. A small campfire built close to the sleeping area helped to take the chill off cool nights. A campsite was occupied only as long as the surrounding area continued to yield food. When the fruit or game played out, the Héta abandoned the camp and pushed on to another site in the forest, where new shelters were erected.

To cut the saplings needed for these shelters, as well as for other types of cutting, the Héta used a stone ax. I was fascinated by this implement. The blade was nearly oval in cross section, and the bit was sharpened to a keen edge. The butt was buried deep within the thick upper part of the wooden handle, which was about two to three feet long. In the hands of one skilled in its use, the stone ax was, as I came to see, an effective tool.

I was anxious to find out how a stone ax was made, but it was suddenly announced that our expedition had to leave. I was dismayed, fearing that a unique opportunity was being lost. And it almost was. Not until 1960, four years later, did I have another chance to visit the Héta and to observe a stone ax being made.

When I first asked the Héta to make a stone ax, they thought my request absurd. The steel axes they had received from us had quickly displaced their own bludgeonlike stone axes, which they now considered obsolete. To make another one at this point seemed to them not only onerous but pointless. Moreover, why on earth should the bearer of such a peerless instrument as a steel ax want to witness the making of a stone one?

My urging was fruitless, and my insistence only amused them. My pantomiming struck them as comical, and they laughed at me. How could I possibly make them understand? They knew no Portuguese; I knew no Héta.

Days passed, and the Héta were no nearer complying with my request. At best, I was being politely tolerated. Finally I decided to change my tactics and to direct my entreaties to Alúa, the wife of a man named Eirakán. I asked her, as best I could, to urge her husband to bring home some stones suitable for

making an ax. Miraculously, it worked. Late one afternoon a hunting party, returning from inspecting the traps and collecting insect larvae for the evening meal, brought with them several river cobbles. I was delighted that I was about to witness what perhaps no other white man in the New World had ever seen—or at least reported.

I learned that the first step in the making of a stone ax is to carefully select the stone itself. A stone should be of the proper size and have the approximate shape of the finished ax, that is, an elongated ovoid. By beginning with a stone of this shape, much less abrading is required, thus saving the ax maker many hours of work. Besides being the right size and shape, the stone must be tough enough to withstand the many blows it will have to deliver. As a precaution, a stone is carefully inspected for cracks or flaws beforehand, since the slightest defect may cause it to fracture the first time it is used, thus wasting perhaps several days of work.

The hammerstone used for pecking should be slightly harder than the stone used for the ax head, shaped so that it feels comfortable in the hand, and not so large that wielding it will tire the worker.

Although he had brought back the necessary raw materials, Eirakán still could not understand why I wanted to see him use them. Nonetheless, early the next morning he sat down on a mat close to the fire, the two stones next to him, ready to start working. He spread his knees, brought the soles of his feet close together, and placed the ovoid stone between them. Then, taking the hammerstone in his hand, he began to peck.

But the sun was not yet high enough for filming, and as I wanted to make a full photographic record of the work, I asked Eirakán to stop. Now he knew I was crazy. First, I had pestered him for days to make a stone ax, and now that he was about to do so, I was asking him to stop. Surely I was deprived of all reason.

I pointed to the sun and then to my equipment a few times, at last managing to convey to Eirakán some dim notion of why I wanted him to wait. Obligingly, he laid aside the stones and decided to have his breakfast. Out came a few

The ax head is inserted into a hole gouged into the handle with a tapir bone, right. Tamping on the opposite side firmly secures the blade.

fat larvae from the previous day's catch, which he roasted in the fire and ate along with a piece of monkey meat and some palm nuts.

By the time he had finished his meal, the sun had risen above the trees, and I had enough light to film. I nodded for him to proceed. Again, using his feet as a vise, he gripped the oval stone, and began pecking away. He pecked at the surface of the stone with light, carefully directed blows. No chips or flakes came off during the pecking, only fine granules. Little by little, the hard, water-polished cortex of the stone was completely removed, and the cobble was lightly pitted over its entire surface. Stone dust soon covered his hands and feet and accumulated on the mat beneath him.

As he worked, Eirakán repeatedly examined both sides of the stone, pecking at spots that seemed a little high, making sure the ax blade would be entirely symmetrical. For several days he labored diligently, stopping only to inspect the traps and collect larvae or fruit. The work necessarily proceeded slowly since great care had to be taken. Too hard a blow and the ax blade might crack in his hands. Or a careless blow near the cutting edge might knock off more than desired, and the entire bit would have to be trimmed down to form a new edge. The work seemed endless to me, and I was beginning to see why Eirakán and the others had thought my request senseless. Still, all was going well and I fully expected the ax to be completed.

But one afternoon Eirakán, returning wet and tired from a foraging trip, took sick. Before he had recovered, our expedition had to return to Curitiba. I left the Héta with the greatest reluctance, despairing of ever seeing the ax finished. Lacking the financial resources to mount another expedition myself, I was not even sure that I would ever return to the Ivaí River. And even if I were to, the forest was being destroyed so rapidly that I seriously wondered if there would be any Héta left.

But six months later I was able to make still another trip to the tribe. I knew very well, though, that this was my last chance to see the stone ax finished, and that I had to take full advantage of it.

Eirakán was again in good

health, but his mood had changed. He no longer had any interest in finishing the stone ax. But I was not to be dissuaded easily, and I kept prodding him. Finally, somewhat annoyed at my insistence, he yielded. Off he went to a spot deep in the undergrowth and came back with the two stones. They were exactly as I had last seen them six months before.

Once more Eirakán began to work, sitting on his mat, his legs spread, his feet clamped around the stone. But again he fell ill, this time with influenza, which is often a serious ailment for an Indian. Things looked bad. But I had tried too hard and gone too far to give up now, so I approached another man, Ñango, and asked him to take over the work. Ñango, however, couldn't see any more sense in it than Eirakán had. He already had a steel ax, why should he make a stone one?

Nothing I said could induce Ñango to resume the work, and as a last resort I appealed to Táhey, the headman of the group. There was no show of authority, no issuing of commands. Táhey merely said a few words to Ñango, and the latter sat down, picked up the stones, and began to work.

Ñango pecked at the blade until at last it was reduced to the proper size and shape. This particular specimen was about six inches long, although others I had seen varied in size. Next came the grinding and polishing. A large sandstone cobble was brought in for the purpose, along with some white clay, which Ñango put into a water-filled container made from a folded palm spathe. He then took the ax head, dipped it into the container, held what was to be the cutting edge firmly against the sandstone with his hands, and began rubbing. He ground one side of the ax, turned it over, ground the other side, went back to the first side, and so on.

During the grinding, Ñango paused many times to renew the clay coating by dipping the ax head in the container. I had always assumed that grinding and polishing a stone ax were two separate operations, but the Héta performed them simultaneously: the sandstone ground while the clay polished.

A great deal of pressure was required to grind the ax blade, and the work was tiring. The sun was

high and hot, and the sweat rolled down Ñango's body. Yet, while it was obvious that he did not relish the work, he stuck to it dutifully. Only occasionally did he interrupt it to inspect the traps and to eat.

Finally, after a full afternoon's work, the grinding and polishing were done. Ñango, who had consulted Táhey several times during the work, now brought the finished ax blade to him for his approval. Only the cutting end of the ax head had been polished; the butt end was left rough so that it would hold more securely in the wooden handle. Since the blade formed one continuous curve, with no groove or notch for lashings, technically the implement was a celt, not an ax.

Now that the blade was ready for hafting, it was Eirakán who offered to do so. He had regained his health and actually seemed enthusiastic about finishing the ax. The next day he went into the forest and came back with a section of tree trunk about four feet long and five inches in diameter.

Hafting the ax proved easier than I imagined. First, Eirakán stripped the bark off the end of the hardwood trunk he had selected to receive the blade. This was the end with the most knots, since knot wood is harder and therefore more resistant to splitting under the heavy blows that a stone ax will deliver.

Eirakán pulled the leg bone of a tapir out of his work basket, broke off one of the condyles with a stone, and sharpened the jagged end of the shaft on the sandstone until he had a serviceable chisel. He then placed the butt end of the ax head against the knotty end of the trunk, and using the edge of the chisel as a marker, outlined the area he would gouge out to hold the blade. This done, he knelt on the trunk to secure it firmly, and using a hammerstone, he pounded the chisel into it.

Much to my surprise, the chisel withstood the heavy blows without breaking, although it did have to be resharpened several times. In half an hour Eirakán had cut out a deep oval hole in the knotty end of the trunk. It did not go all the way through the wood, but was just big enough to hold the butt end of the ax head securely. Eirakán pressed it into the hole until he knew it would fit tightly, then removed it.

Since the section of tree trunk

was still too thick to hold in the hand, it had to be trimmed down. Eirakán first cut a groove around the trunk a little below where the ax head was to be inserted. Then, hammering the chisel into the wood below this and using it as a wedge, he pried away long splints of wood all the way up to the groove. In this manner, the handle was reduced in size until it was about two inches thick, with a slight taper toward the lower end. The end itself was then beveled with a stone flake. The handle was scraped lightly with a stone scraper, but not really smoothed.

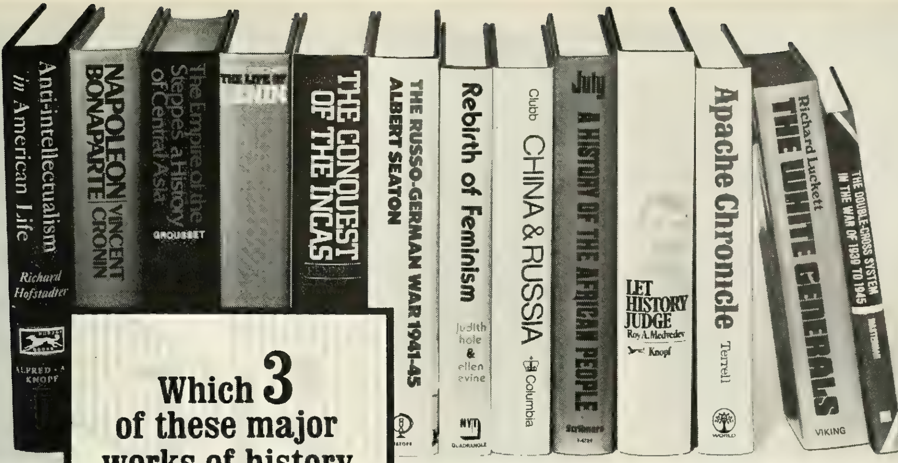
Finally, with the handle finished, the blade was pushed into the hole made for it and lodged firmly in place by tamping hard on the opposite side a few times. No resin, beeswax, or other adhesive was used to help hold the blade in place, and no lashings of any kind were employed. The green wood was hard and succulent enough to hold the ax head securely.

And so the stone ax was finished. Under favorable conditions, the Héta could make a stone ax in three to five days, with another half-day for hafting. This one had taken seven months. Eirakán was proud of his work. After showing the ax to everyone in camp, he finally presented it to me as a gift.

If carefully pecked from good tough stone, an ax can last a long time. It requires frequent sharpening, however, and would eventually be ground down to a good deal less than its original size. If the blade should come loose, it can be secured in place again by tamping the back of the ax a few times, just as was done to insert it in the first place.

The Héta used the stone ax in a variety of ways. Most important, of course, was its use as a cutting tool for felling trees. Almost any tree could be felled with a stone ax. I have seen trees four feet in diameter that the Héta had felled to serve as a bridge across a deep stream. Starting with well-sharpened axes, it took four men a day's work to fell a tree of that size.

In addition to cutting, a stone ax was used for cracking nuts, chipping bones, and grinding and hammering in general. The handle, too, had a number of uses. Its sharpened end served as a crowbar, which was



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After felling a tree, the Héta use the pointed end of the ax handle to dig out a honeycomb. The honey is then caught in a gourd.

driven into a rotten tree and moved back and forth in search of insect larvae. Pounded into the ground with a heavy stone, it made holes for shelter poles. It functioned as a digging stick, and was used to excavate pit traps. And occasionally, when wielded as a club, the stone ax could be a dangerous weapon.

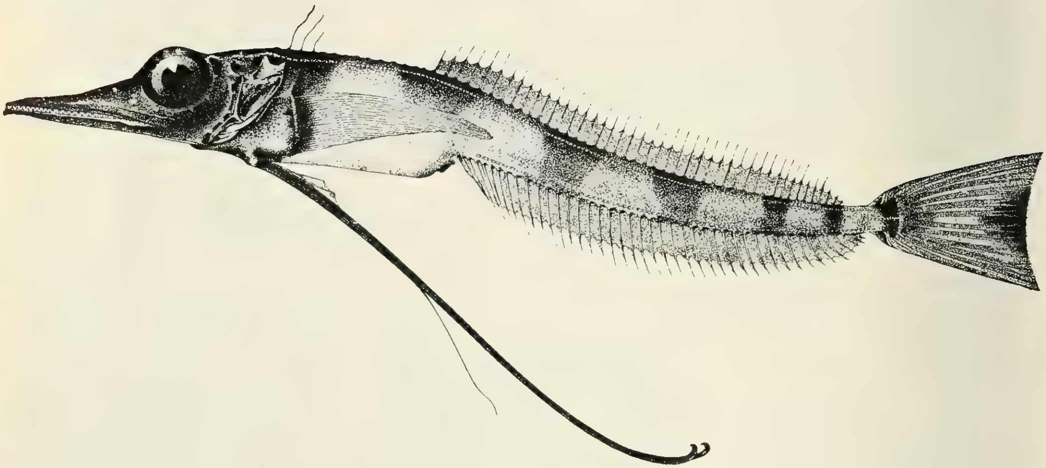
Sometimes a carrying cord of bark was attached to the ax. With his stone ax hanging from the back of his neck by means of such a cord, a Héta thus had his hands free to climb a tree. Once there, he could swing his ax to cut out a honeycomb or cut down a cluster of palm nuts.

The Héta will never use the stone ax again. Indeed, the tribe, as such, exists no more. The forest, which for centuries was their source of food as well as their shield against the outside world, has rapidly given way to coffee plantations. And as the forest dwindled in size, it became increasingly more difficult for the Héta to extract a living from it. Diseases acquired from the white man decimated the population, and those Héta who managed to survive saw the futility of staying on. They left the forest, some to work as farm laborers, others to seek a livelihood as best they could outside of it.

Less than two decades ago, there were more than 150 Héta. Today there are only fifteen, and because almost all of these were children when they were taken from the forest, they never had a chance to learn much of their own culture. Héta culture, thus, is extinct. Of those Héta who left the forest as adults, only two—one of whom is Ñango—are still living.

Since the Héta were discovered, three or four other Amazonian tribes that also used stone axes have come to light. But they, too, quickly gave up their stone tools for steel ones. The forest Indian is a dedicated pragmatist for whom the faithful cutting tool of a thousand years commands no loyalty. Confronted with the clear superiority of the steel ax, he gives up his stone tool without the slightest hesitancy. Indeed, the change occurs so swiftly that there is usually no one around to note it, let alone to record how the old stone ax was made or used. Only by a stroke of luck was I once able to do so. It is not likely that anyone in this hemisphere will ever have that chance again. ■

One Small Step for Science, One Good Meal for the Ship's Cat



"In no expedition that ever sailed from Europe has more care been taken to collect the zoological productions of the sea, than in the pre-eminently scientific one of the *Erebus* and *Terror.*" So wrote an English doctor and naturalist, John Richardson, about "the survey . . . of novel design" that set out in 1839 to locate the south magnetic pole and chart some portion of the mysterious southern continent. Richardson did not accompany the voyage himself, but he did receive most of the fishes that were caught on this famous expedition.

The *Erebus* and *Terror* were under the command of Sir James Clark Ross, and happily for the young science of marine biology, Sir James was eager to discover all the fish and worms and shellfish that might inhabit the cold and unknown waters of the Antarctic. With him, therefore, he brought Joseph Hooker, a botanist at the beginning of an illustrious career, and John Robertson, a surgeon-naturalist. Both men were heartily encouraged to collect and preserve whatever creatures they could find, and so they did.

On February 20, 1842, "when the ships were in the high latitude of 77° 10′ S., and long. 178½° [W] [in what is now known as the Ross Sea], a fish was thrown up by the spray in a gale of wind, against the bow of the *Terror,* and frozen there."

The sailors discovered the little fish as they made their rounds of the ship, chipping away the coating of ice that daily threatened to transform the vessel into a beautifully frosted but dangerous and unmanageable statue. The fish was carefully pried from the bow and given to Robertson. The doctor carried this very first specimen of a fish caught within the Antarctic Circle to his cabin, where despite its frozen condition, he made a rough sketch of it, noting that "the ground colour of the body is pale blue; much of the head, and the vertical bands are dark neutral tint, and minute dark specks are scattered over the body and caudal fin." He then placed the fish, which

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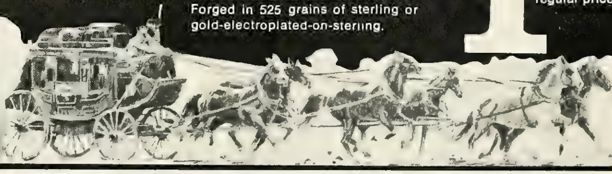

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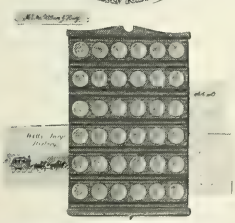

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measured only 6¼ inches in length and an inch in diameter, in a pan to thaw. He intended to examine this rare specimen more thoroughly and eventually to preserve it in alcohol for the long trip home.

But before it could be put into spirits, Richardson reported later, "a cat carried it away from his [Robertson's] cabin, and ate it."

Robertson, with feelings he did not record, named the missing fish *Pagetodes*, a Greek word meaning "frozen solid." A year later, when the *Erebus* and *Terror* sailed back to England, he gave Richardson his notes on *Pagetodes* along with his more tangible collections, which did not include other fish from such high latitudes.

Excepting some unrecorded captures that might have been made by southern peoples, that dinner for the ship's cat was the first Antarctic fish that had ever been caught. In the years preceding the voyage of the *Erebus* and *Terror* at least eight explorers had sailed south of latitude 66°30′S., but although these were observant men (Captain James Cook, the first to cross the circle in 1773, noted the "inexpressibly horrid aspect of the country"), none mentioned even the sighting of a single fish. And neither did the men who explored the Southern Ocean after Sir James's expedition.

The famous *Challenger* crossed the Polar Circle in 1874, the first ship with an auxiliary engine to do so, as did the *Jason*, the *Hertha*, and the *Antarctic*, but as before, no mention was made of any fish.

Then in 1897 a young lieutenant in the Belgian navy, Adrien de Gerlache, launched a remarkable expedition in the tiny three-masted bark *Belgica*. His intent was to let his 100-foot vessel be trapped in the ice pack somewhere south of South America and to make continuous meteorological and oceanographic observations as the *Belgica* drifted all winter long in the ice.

The *Belgica* left Antwerp in August, 1897, and after many a storm (and a short layover in Rio de Janeiro to pick up a medical doctor from Brooklyn, New York), sailed to Punta Arenas, Argentina, and from there proceeded south and west to the edge of the ice.

For a month or more, de Gerlache and his officer Roald Amund-

sen, subsequent discoverer of the South Pole, attempted to sail through the pack ice in the belief that a navigable sea lay beyond, but in mid-February they gave up this idea and sailed due south. The ship crossed the Polar Circle and a month later was frozen in.

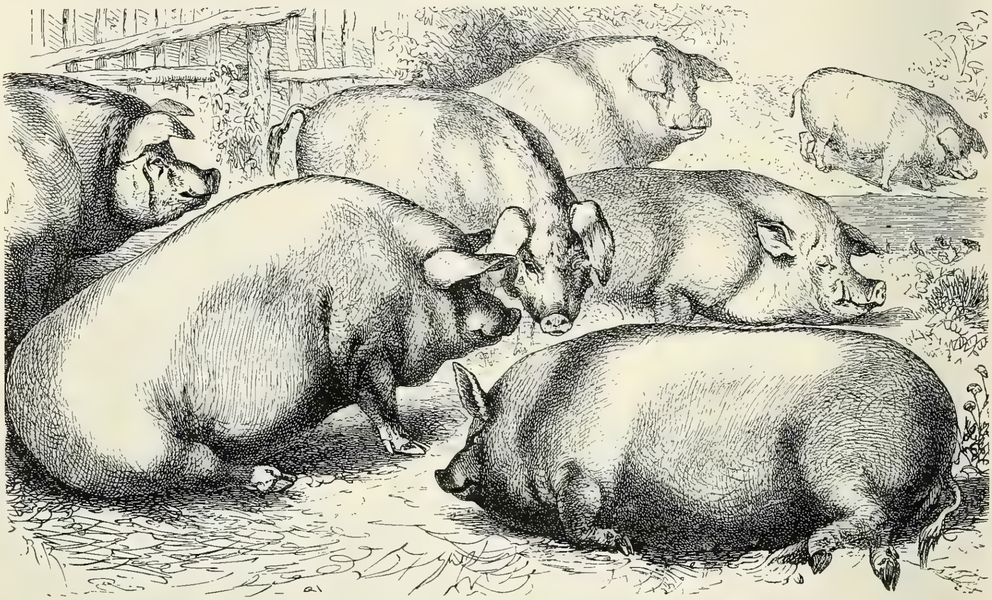
There were four scientists on board the *Belgica*, and during the long days of the southern summer they chopped holes in the ice and through them lowered sounding lines, plankton nets, and hempen tangles attached to an iron bar. These tangles were usually left down for a full 24 hours in hopes that the slowly drifting ice would drag them across some part of the sea floor populated by more than just sand and pebbles.

On May 17, 1898, a little more than 56 years after the first recorded specimen of Antarctic fish was snatched from science, the trawls were sent down to a depth of about 1,500 feet, and the next morning, after being slowly hauled to the surface, they were found to have snagged an exciting variety of animals: a sponge, a starfish, several sea fans and shellfish, a brittle star, and a single, small fish. All the specimens were preserved in alcohol and packed away in hopes they would someday reach the Royal Museum of Natural History in Brussels.

Some seven months later, after a long and gloomy winter, it became apparent that the southern summer of 1899 would not be as warm as usual and that the *Belgica* would not be released from the ice pack. With one death and two insanities already weighing on the men's spirits, the thought of another dark year in the ice was more than they could endure, and with the ship's three small ice saws they set about opening up a channel through ice six feet thick. After a month and a half of constant work, night and day, they had made a half-mile-long channel that reached from the imprisoned ship to open water.

The *Belgica* and her tired but triumphant crew returned to Europe and her treasures were deposited in the Brussels museum. There Louis Dollo, an ichthyologist, minutely examined the fish caught on May 18, gave it the scientifically acceptable name of *Cryodraco antarcticus*, and proclaimed it to be that rarest of cat foods—*Pagetodes!* ■

Riddle of the Pig



There have been many explanations for the dietary laws against pork, but none seemed quite kosher

When the God of the ancient Hebrews told them not to eat pork, He must have realized that generations of scholars were going to try to figure out why. From my ecological perspective, I would like to offer an explanation that relates Jewish and Muslim attitudes toward the pig to the cultural and natural ecosystems of the Middle East.

Naturalistic explanations for the taboo on pork go back to Maimonides, who lived in the twelfth century. Maimonides said that God had intended the ban on pork as a public health measure since swine's flesh "had a bad and damaging effect upon the body." This explanation gained favor in the mid-nineteenth century when it was discovered that there was a parasite present in undercooked pork that caused trichinosis.

Impressed by this rational answer to the ancient riddle, American Jews who belonged to the reformed congregations proceeded forthwith to revoke the scriptural taboo on the grounds that if properly cooked, pork no longer menaced the community's health. But Maimonides's explanation has a big hole in it: the flesh of all undercooked domestic animals can serve as a vector for human diseases. Cattle, sheep, and goats, for example, transmit brucellosis and anthrax, both of which have fatality rates as high as that of trichinosis.

Although Maimonides's explanation must be rejected, I think he was closer to the truth than modern anthropologists, including Sir James Frazer, renowned author of *The Golden Bough.* Frazer declared

that pigs, like "all so-called unclean animals were originally sacred; the reason for not eating them was that many were originally divine." This doesn't help us very much since the sheep, goat, and cow were also once worshiped in the Middle East, and yet their meat is much enjoyed by all ethnic and religious groups in the area.

Other scholars have suggested that pigs, along with the rest of the foods prohibited in the Bible, were the original totem animals of the Hebrew clans. But why interdict the consumption of a valuable food resource? After all, eagles, ravens, spiders, and other animals that are of only limited significance as a source of human food are also used as clan totems.

Maimonides at least tried to place the taboo in a natural context in which definite, intelligible forces were at work. His mistake was that he conceived of public health much too narrowly. What he lacked was an understanding of the threat that the pig posed to the integrity of the broad cultural and natural ecosystem of the ancient Hebrew habitat.

I think we have to take into account that the protohistoric Hebrews—the children of Abraham—were adapted to life in the rugged, sparsely inhabited arid lands between Mesopotamia and Egypt. Until their conquest of the Jordan Valley in Palestine, which began in the thirteenth century B.C., they were primarily nomadic pastoralists, living almost entirely on their sheep, goats, and cattle. But like all pastoral peoples they maintained close relationships with sedentary agriculturalists who held the oasis and fertile river valley.

From time to time certain Hebrew lineages adopted a more sedentary, agriculturally oriented mode of existence, as appears to have been the case with the Abrahamites in Mesopotamia, the Josephites in Egypt, and the Isaacites in the western Negev. But even during the climax of urban and village life under David and Solomon, the herding of sheep, goats, and cattle continued to play a vital, if not predominant, economic role everywhere except in the irrigated portions of the Jordan Valley.

Within the over-all pattern of this mixed farming and pastoral complex, the divine prohibition

against pork constituted a sound ecological strategy. During periods of maximum nomadism, it was impossible for the Israelites to raise pigs, while during the semi-sedentary and even fully village farming phases, pigs were more of a threat than an asset. The basic reason for this is that the world zones of pastoral nomadism correspond to unforested plains and hills that are too arid for rainfall agriculture and that cannot easily be irrigated. The domestic animals best adapted to these zones are the ruminants—cattle, sheep, and goats. Because ruminants have sacks anterior to their stomachs, they are able to digest grass, leaves, and other foods consisting mainly of cellulose more efficiently than any other mammals.

The pig, however, is primarily a creature of forests and shaded river banks. Although it is omnivorous, its best weight gain is from food low in cellulose—nuts, fruits, tubers, and especially grains, making it a direct competitor of man. It cannot subsist on grass alone and nowhere in the world do fully nomadic pastoralists raise significant numbers of pigs. The pig has the further disadvantage of not being a practical source of milk and of being difficult to herd over long distances.

Above all, the pig is ill-adapted to the heat of the Negev, the Jordan Valley, and the other biblical lands. Compared to cattle, goats, and sheep, the pig is markedly incapable of maintaining a constant body temperature when the temperature rises.

In spite of the expression "to sweat like a pig," it has now become clear that pigs can't sweat through their relatively hairless skins. Human beings, the sweatiest of all mammals, cool themselves by evaporating as much as three ounces of body liquid per hour from each square foot of body surface. The best a pig can manage is one-tenth ounce per square foot, and none of this is sweat. Even sheep evaporate twice as much body liquid through their skins as pigs. And sheep have the advantage of thick white wool, which both reflects the sun's rays and provides insulation when the ambient temperature rises above body temperature. According to L. E. Mount of the Agricultural Research Council Institute of Animal Physiology in Cambridge,

England, adult pigs will die if exposed to direct sunlight and air temperatures over 97 degrees F. In the Jordan Valley, air temperatures of 110 degrees occur almost every summer and there is intense sunshine throughout the year.

To compensate for its lack of protective hair and its inability to sweat, the pig must dampen its skin with external moisture. It usually does this by wallowing in fresh, clean mud, but if nothing else is available, it will cover its skin with its own urine and feces. Mount reports that below 84 degrees F. pigs kept in pens deposit their excreta away from their sleeping and feeding areas, while above 84 degrees they excrete throughout the pen.

Sheep and goats were the first animals to be domesticated in the Middle East, possibly as early as 9000 B.C. Pigs were domesticated in the same general region about 2,000 years later. Bone counts conducted by archeologists at early prehistoric village farming sites show that sheep and goats were in the majority while the domesticated pig was almost always a relatively minor part—about 5 percent—of the village fauna. This is what one would expect of a creature that ate the same food as man, couldn't be milked, and had to be provided with shade and mudholes. Domesticated pigs were from the beginning an economical and ecological luxury, especially since goats, sheep, and cattle provided milk, cheese, meat, hides, dung, fiber, and traction for plowing. But the pig, with its rich, fatty meat, was a delectable temptation—the kind, like incest and adultery, that mankind finds difficult to resist. And so God was heard to say that swine were unclean, not only as food, but to the touch as well. This message was repeated by Mohammed for the same reason: it was ecologically more adaptive for the people of the Middle East to cater to their goats, sheep, and cattle. Pigs tasted good but they ate you out of house and home and, if you gave them a chance, used up your water as well. Well, that's my answer to the riddle of why God told the Jews and the Muslims not to eat pork. Anyone have a better idea?

Columnist Marvin Harris teaches anthropology at Columbia University.

The Secret Life of Beatrix Potter

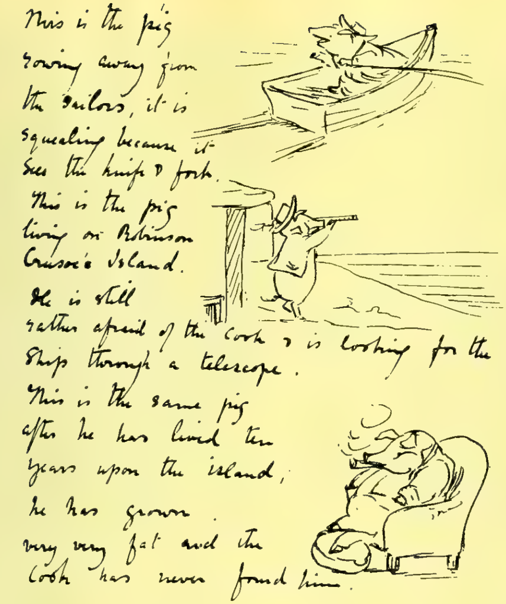
When England's chauvinistic male scientists ignored the shy naturalist, she turned to a new career... and delighted generations of children

by Naomi Gilpatrick

Waiting for the director of the Royal Botanic Gardens to appear, the young woman stood, silent and watchful, in the shadow of the trees. Beatrix Potter was half-inclined to flee. Her theories on symbiosis, which she had written up in a paper on the germination of spores, went beyond what was known in 1896, and she needed a sponsor. But the director of the Gardens had no time for her or her discoveries. She watched two women assistants at work, and after learning that they were "obliged to wear knickerbockers," she wrote in her journal, using a code alphabet of her own invention, that the director "may be a misogynist."

Following Beatrix Potter's death in 1943 at the age of seventy-seven, Leslie Linder, an engineer whose leisure-time hobby was collecting Potter drawings, heard that a bundle of pages in keyless code had been found in the farmhouse of the author of *The Tale of Peter Rabbit.* Challenged, Linder worked on and off for years trying to break the code. He finally succeeded in 1958, but it took him several more years to decipher the diary. Beatrix Potter's *Journal,* covering the years from 1881 to 1897, was published in 1966, and in it can be found the story of her efforts to present her theories to the scientific authorities of the time, who reacted as though "one must not speak to them."

She would have liked to discuss her growing portfolio of fungus and lichen drawings with some of the scientists at the Botanic Gardens. She had questions to ask—small, moot points that weren't touched upon in any of the books she had consulted. She had never gone to school; instead, she had been tu-


This is the pig rowing away from the sailors, it is squealing because it sees the knife & fork.
This is the pig living on Robinson Crusoe's Island. He is still rather afraid of the cook & is looking for the ships through a telescope.
This is the same pig after he has lived ten years upon the island; he has grown very very fat and the cook has never found him.

Many of Beatrix Potter's books originated as story-letters to friends. This early version of *The Tale of Little Pig Robinson* was written 36 years before the book was published.

That is the end of the story. Old Brown carried Nutkin into his house, and held him up by the tail, intending to skin him; but Nutkin pulled so hard that his tail broke in two, and he dashed up the stair-case, and escaped out of the attic window.

And to this day, if you meet Nutkin up a tree, and ask him a riddle, he will throw sticks at you, and chatter his teeth, and scold, and shout – "Cuck cuck cuck cuck Cur-r-r-r."!

Yours aff. Beatrix Potter

Norah Moore, to whom *The Tale of Squirrel Nutkin* was dedicated, received the first version of the story in a letter, right, dated September 25, 1901.

tored by governesses hired to teach her French and German. She had made good use of this by consulting natural history books in both these languages, especially those by Louis Pasteur and Oskar Brefeld. Her own observations, made not only in her third-floor study but also on frequent holidays to seacoast towns with her father, a leisure-class photographer, had brought her, in her twenties, to the forefront of what was known about lichens and fungi.

In her father's company, she found that Sir William Flower, who was associated with the Museum of Natural History at South Kensington, would acknowledge her, but at the museum he would walk past as if she weren't there. One Sunday, she attended a gathering at the home of the local police magistrate, hoping to meet and confer with Sir William there. But she was sitting in a darkened alcove of the room when he entered and he gave no sign of recognizing her. That night she wrote in her journal, "I wonder if people know the pleasure they may give a person by a little notice."

Trudging the fields hadn't equipped her for the small talk necessary to initiate a conversation. Too long had she silently assisted with the camera while her voluble father carried on animated conversations with the great men he photographed: John Bright, a member of Parliament; Prime Minister Gladstone; and the painter Sir John Millais, who said, in her presence, that the length of her nose and upper lip spoiled her face. No wonder she couldn't lift it from the museum's fossil cases to get the answers she needed.

She wrote in her journal that the museum "is the quietest place I know—and the most awkward. They have reached such a pitch of propriety that one cannot ask the simplest question." Her frustration mounted as she studied the labels on insects. "I worked into indignation about that august Institution. The clerks seem to be all gentlemen and one must not speak to them."

Holiday trips with her parents, which allowed her to explore quarries for fossils, made her feel that "with opportunity the world is very interesting." At the age of twenty-eight she observed a falling meteor, but decided that she wouldn't start

Cantharellus cibarius

Gomphidius glutinosus

Lenzites sepiaria

to study the stars, with forty thousand named and classified fungi yet to be observed. By then, she had found and painted more than two hundred species.

During her teens and twenties, Beatrix Potter's search for fungi took her out of doors each day that weather permitted. Nothing discouraged her, not even the average of seventy insect bites ("suspect spiders") that she received on each search. What mattered was climbing over a hedge, going into a wood, and finding "a paradise of funguses." Even the danger of getting lost in the depths of a black fir forest did not deter her from plunging through the bracken until she found the yellow *Peziza* in the moss or the gigantic *Cortinarius.*

Her search for fungi was unremitting. The emotion she recorded upon coming across a new species for the first time was "joy of joys." She went deeper and deeper into "the green fogginess and tangle," pausing at what seemed to her "an ideal heavenly dream. . . . The fungus starred the ground apparently in thousands."

Beatrix Potter, before she turned to writing for children, was the first person in England to affirm that the colorful patches growing on trees, fences, tombs, and rocks were actually a merging of two discrete plants—an alga and a fungus—to make a third kind of plant, a lichen, which in function and longevity was different from either of the two originators.

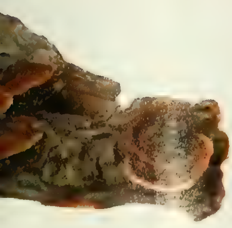
In 1867 the Swiss botanist Simon Schwendener was the first to describe lichens as dual organisms, but British botanists rejected this announcement. In 1874, when Beatrix Potter was eight years old and already assiduously painting and labeling caterpillars in her sketchbook, the English botanist J. M. Crombie came out with a sardonic dismissal of Schwendener, who, he wrote, was advancing an "unnatural union between a captive Algal damsel and a tyrant Fungal master." In an article ten years later in the *Journal of the Linnean Society,* Crombie continued to denounce the "alga-lichen hypothesis."

In 1879 a German botanist, Heinrich de Bary, coined the word *symbiosis* to designate a sharing of physiological mechanisms by dis-

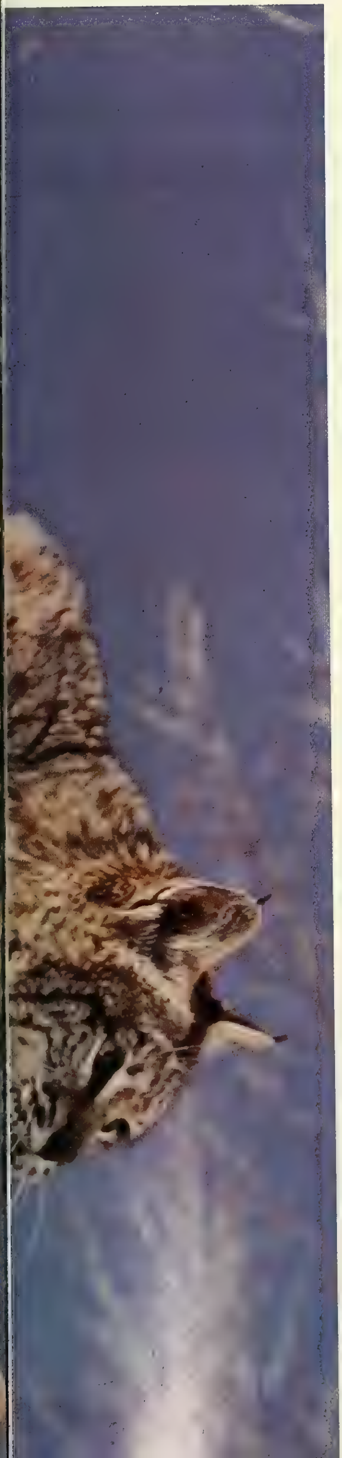
Continued on page 88

Panellus stypticus

ygrophorus psittacinus



Collybia (Flammulina) velutipes



The Elusive Bobcat

This small, secretive cat establishes territories and pursues its prey within the shadow of man

by Theodore N. Bailey

Seldom seen and rarely heard, the elusive bobcat still hunts the rock outcrops and thick brush over much of North America. From the Atlantic to the Pacific and from southern Canada through Mexico, the bobcat is found in areas where other, larger carnivores have long since been exterminated. Primarily nocturnal, but active at any hour, bobcats range over a wide variety of habitats—from swampy bayous to parched deserts and snow-covered mountains—their presence often unnoted even by people living in close proximity.

While there is an abundance of folk names for the bobcat, few provide any factual information about the animal. Commonly called a lynx cat, or simply, wildcat, the American bobcat is often confused with the Canadian lynx to which it is closely related. Distinguishing it from the similar-sized lynx, however, is a more colorful, spotted brown-and-gray coat, a longer tail, shorter legs, and less prominent ear tufts.

Slightly more than three feet long, bobcats average from fifteen to thirty pounds, have a prominent ruff of fur below their pointed ears, and six-inch tails. Their low profile, cryptic coloration, and large feet allow them to move stealthily through low cover.

Because of the bobcat's secretive nature, data on the animal's social behavior, spatial requirements, and density have been scanty or nonexistent. To obtain some of this information, in 1969 I began a three-year study of bobcats. My objectives were to calculate the number of bobcats living in a given area; determine the influence of food, habitat, and social behavior on their numbers; and by measuring productivity, mortality, and dispersal, learn how these influences operate.

My study area comprised about 250 square miles located within the boundaries of the Atomic Energy Commission's National Reactor Testing Station in southeastern Idaho. Situated on the upper Snake River Plain, the region encompasses many lava flows, caves, and volcanic craters. Remnants of ancient volcanoes tower more than a thousand feet above the rocky plain. In this semiarid, sagebrush-covered country, frequent winds create a harsh environment, blowing dust in the hot summers and snow in the winters. Because strict security measures in the area ban hunters and trappers, bobcats and their prey were relatively abundant. A picturesque bonus was provided by the region's beautiful sunsets, delicate flowers, lichen-encrusted rocks, and undulating snowdrifts.

During this study, I captured 66 live bobcats, both adults and young, and equipped 17 with radio transmitters. I also examined more than 300 specimens that had been killed by fur trappers in nearby regions.

Light November snows are a portent of the heavier accumulations that will restrict bobcat movements during the Idaho winter.

From this field work, I pieced together a picture of bobcat behavior and ecology in this part of its range.

The preferred habitat was rocky or broken terrain where prey was abundant and cover sufficient for a successful stalk or ambush. I estimated that about 35 adults resided on or used parts of the area. In addition, at least seven litters were born annually, and an undetermined number of transient bobcats passed through each year.

Their marking behavior, spatial distribution, and the presence of the same individuals in the same localities each year suggested that the cats were territorial, but not in the classical "defense of an area" sense that describes certain bird behavior. Their territories were too large to readily defend, and only places of special significance, such as caves and rock piles, were marked. Some territorial overlap is common in this type of spatial organization and was greatest among adult males and least among adult females. A male's territory often overlapped that of several females. Encounters were held to a minimum because resident cats rarely used the same areas simultaneously.

Significant places within territories were marked with feces, scrapes, and urine. Droppings, left uncovered at such conspicuous landscape features as ant mounds, rock outcrops, trails, and small clearings, served as marking locations. A bobcat smelling fresh feces apparently knew that the area had recently been visited and could change its movements to avoid an encounter. Females, especially those with young kittens, appeared to mark most intensively.

Bobcats also advertised their presence with urine, which they squirted on rocks, snowbanks, and bushes near their retreats. Scrapes, or scratch marks, also appeared to be significant in communication. In addition, the peanut-sized scent glands situated on each side of the anus probably produce a pheromone that permits sexual or individual recognition.

The distances that bobcats moved depended on sex, age, breeding condition, weather, and prey availability. Females with small kittens usually hunted within a one-mile radius of the den, but expanded their movements as the kittens matured. Adult males moved greater distances over extended periods before returning to previously visited areas. I calculated that adult female ranges encompassed up to six square miles, males up to 67 square miles, but the bobcats did not use the entire area within such a range nor did they inhabit the entire study area.

Examination of feces from the

Using sagebrush and rocks for cover, a seven-month-old male begins to search for prey. At this young age his chances of success are slim.

study area showed that jackrabbits and cottontails made up more than 90 percent of the bobcat's diet, and that rodents and birds were the next most frequently eaten prey. In the more diversified habitat of the nearby mountains where rabbits and hares were less plentiful, bobcats preyed more heavily upon rodents and birds.

The remains of mule deer were found in 9 percent of the bobcats examined from the mountains, but none were found in the feces from the study area. Although bobcats are capable of killing a deer, particularly in the winter, they probably do so only if more easily captured prey is scarce. Attacking an animal with sharp hooves or antlers can be hazardous, as was revealed by the broken facial bones and missing teeth of some of the bobcats examined from the mountains. Many deer die each winter from natural causes or gunshot wounds, so it is possible that some deer are already dead before being discovered and eaten by bobcats. For example, one study revealed that 23 of 26 deer kills eaten by bobcats were carrion.

Bobcats at times kill domestic sheep, thereby incurring the wrath of some stockmen who proceed to advocate their extermination. But the evidence from studies of bobcat food habits in sheep country indicates that such kills are infrequent. I examined the stomach contents and feces of nearly 300 bobcats but in only one instance did I find sheep remains. I also followed several bobcats near flocks of sheep without observing a single attack.

A young female catnaps in the shade. Basically nocturnal, bobcats avoid the hot sun of a summer afternoon, stirring again toward evening.

To locate prey, the bobcat uses its acute vision and hearing. The bobcat must then place itself in a position that will enable it to capture the prey as quickly as possible. The element of surprise is mandatory: given a second's advantage, the average jackrabbit can outrun the average bobcat.

The technique was demonstrated by an old female hunting for a meal. While traveling along a ridge from which she could see a considerable distance, she changed direction suddenly and carefully approached a well-used jackrabbit trail. Exploring the terrain, she slowly moved in a large semicircle, stopping to hide at five different locations. She eventually found a suitable spot for an ambush behind some sagebrush, and when a jackrabbit came by within six feet, she captured it in one leap.

Cottontails were caught more often than would be expected from their number in the population. They probably were more vulnerable than jackrabbits, which run faster and are more difficult to approach. The slower cottontails often try to hide by freezing in one position instead of running. Because they live in broken, rocky habitat, they can be more easily approached and captured. This prey selection might also explain how two predators such as bobcats and coyotes can coexist even though both use rabbits and hares as a major food source. My preliminary data indicated that jackrabbits occurred more frequently than cottontails in the diet of coyotes in the area.

Territoriality and the food supply appeared to be the main factors regulating bobcat numbers. Despite the number of kittens raised and the number of transient bobcats moving through the study area, the number of resident females remained relatively constant. The breeding density of female bobcats on the study area was apparently limited by their territorial behavior.

The food supply had a strong influence on the total number of bobcats raised. Rabbit and hare populations in the region are subject to periodic cycles of abundance and decline. Population counts indicated that during the first two years of the study, they increased in numbers; in the third year, they declined nearly 90 percent.

Sixteen bobcat kittens were captured during each of the first two years of the study, but only three were captured after the rabbit and hare decline. Since most were at least three months old, this was a good measure of kitten survival. Visual observations at several dens in the spring showed that females had kittens that third year, but subsequent observations and trapping efforts indicated that few offspring survived into the winter. Although no dead young were found, death from starvation was probably the cause.

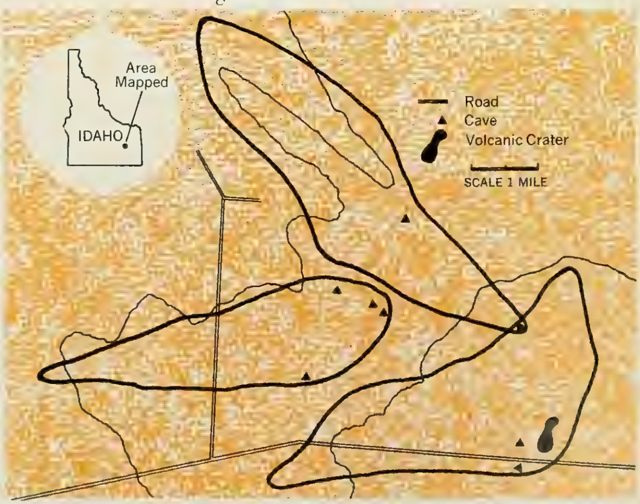
Territorial behavior may have been modified as the food supply dwindled. Three adults—two males and a female—shared the same rock pile during two weeks of severe winter weather after the rabbit and hare decline. Each bobcat entered the rock pile via a separate entrance, remained apart inside, and hunted different areas. No evidence of fighting was observed even when the two males were less than twelve feet apart. Thus, under adverse conditions the territorial system was modified as the bobcats struggled to survive.

Sexually mature bobcats, those at least a year old or older, bred from February through June in this region. This period was one of the few times that males formed any relationship with the females, although some females appeared to tolerate males when their kittens were nearing self-sufficiency. At no time did the males demonstrate any involvement in caring for their offspring.

Most kittens were born in the spring, but some females gave birth as late as August. The average number of kittens per litter was 2.8, with a range of two to five. Older females appeared to have the larger litters, a factor of selective advantage reducing the mortality rate of kittens born to young, inexperienced mothers. For example, one female had two kittens in her first litter and four the following year.

Most of the kittens on the study area were born in protected caves and rock piles where little harm could befall them. The same dens

The Home Ranges of Three Adult Female Bobcats



The element of surprise is needed to overcome the speed of a jackrabbit. Hares made up the bulk of the bobcat diet on the study area.

were used each year if the female and her litter were not unduly disturbed.

Kittens were nursed for about two months before the females brought prey back to the den. When three to five months old, the kittens were led from the natal dens to begin searching for prey. During these forays, the females kept their litters in tow. The female's upturned tail and conspicuous ear patches probably helped the kittens keep their mother in view as they followed her through the dense vegetation during the night. When the kittens are older and they travel separately, vocal calls may be used to keep in contact with each other.

The females were diligent parents. Some remained near their kittens, which I had trapped near their dens, and one female brought a rabbit for its captive offspring. At times, the nearby females threatened by growling as I examined their kittens. Only females with young displayed such bold behavior; other bobcats I observed at close range immediately fled or concealed themselves. Tall stories about hunters facing fierce bobcats tell us more about the nature of the storyteller than about the animal.

Dependence on the female's hunting prowess was a critical factor in the survival of a litter. I once tracked a female for more than a mile as she carried a jackrabbit back through deep snow to her kitten waiting in the rocks. It is likely that if the female is killed during this period of dependency, the litter will starve to death. Young bobcats, unskilled in the art of hunting, were not as successful as adults in capturing prey, even though they made many attempts. One night, a young bobcat I was tracking tried to capture two jackrabbits and two cottontails, but all escaped unharmed.

Slower than the jackrabbit, and more easily stalked on the broken, rocky terrain, the cottontail is a favored prey of bobcats.

In contrast, one adult female successfully captured three jackrabbits on three attempts during different hunts.

Some young bobcats became partially self-sufficient at seven to nine months, spending periods of time alone within their mother's home range, before rejoining her, perhaps after several days of unsuccessful hunting. One mother led one of her kittens, a nine-month-old male, out of his familiar range and returned several days later alone. He did not return.

No kittens were captured within their mother's home range after she had her next litter. When self-sufficient, all young left their home area, and several were later captured by fur trappers twelve to fifteen miles from their birthplaces. Some bobcats have been known to travel nearly 100 miles searching for a place to live. This innate wandering of sexually immature bobcats is of survival value to the species because it prevents overcrowding and insures that new areas will be occupied.

Bobcats usually are not as abundant as similar-sized carnivores within their geographical range. Trapping records indicate that in some areas coyotes may outnumber them by as much as eight to one. Their relative scarcity would seem to result from the combination of a low reproductive rate, restricted feeding habits, and habitat selection. Coyotes usually have twice the number of young per litter as bobcats and eat a greater variety of foods.

The adaptability demonstrated by the bobcats' wide distribution in a variety of habitats offers no assurance of the species' survival. Other cats with wide distributions, such as the American lion and the cheetah, have drastically declined in numbers with the constant destruction of their habitat and harassment by man.

Since bobcats are not protected in much of their range, unregulated hunting and trapping further reduce their numbers. A 1970–71 survey revealed that in 20 states bobcats were still on the bounty lists of some counties, and their pelts are currently selling for over twenty dollars apiece. Recent bans in the United States on the importation of many catskins is an optimistic sign, but until a greater appreciation of this native cat replaces the irrational attitudes held against it, its future remains uncertain.

Down on the

Weeding the cucumbers with a Yale professor at the Marco Polo Bridge People's Commune

Most recent American visitors in China follow a well-worn path—from Canton to Shanghai to Peking—with a visit to historic Sian and Yenan, or some other city of special interest, thrown in for some. They are all put up in Western-style hotels such as the Peking or Hsin Ch'iao in the nation's capital or the Hoping in Shanghai (the splendid old Victor Sassoon Cathay Hotel), where they sleep on Western beds in luxurious suites, eat Western-style food, and talk almost exclusively with other visitors from the West.

When they visit factories, schools, apartment houses, or communes, they are driven in commodious limousines, which move swiftly through the streets, honking pedestrians, buses, and slower traffic out of the way. At their destinations, they are usually met by official delegations from the relevant Revolutionary Committee and then whisked through the establishment on a carefully worked-out and busy schedule. I think it is fair to say that their view of China is at best fragmentary and selected. It is not at all surprising that their reports have been remarkably uniform.

When I was in China for 15 days last year, I insisted on being allowed to walk about by myself part of the time, so that I could observe and photograph whatever came my way. This was valuable and enjoyable, but still limited and selective, since I could perforce walk only in the cities in the vicinity of the hotels where I was staying. My ability to profit from my experiences was further hampered by my complete lack of knowledge of the Chinese language.

This year I have returned to China with my wife, Dale, and daughter, Beth, 23, and the experience is proving quite different in many respects. We are staying for two months rather than two weeks. Almost from the moment of our arrival, we protested against the restriction of our activities to lodging in luxury hotels in big cities, attending formal banquets, and riding around in chauffeured limousines. After a bit of argument, we won a series of small victories that culminated in our being allowed to move, by ordinary bus and walking, to a people's commune for an indefinite stay. And at this writing, we are living in a typical (but fairly well-off) peasant's home, eating ordinary fare, and within the limits of physical endurance, participating in the regular "lao dung," or manual labor, that consumes the larger part of an average commune member's life. It is a life common to the almost 80 percent of China's population—about six hundred million people—who live in rural areas.

We have visited schools, nurseries, clinics, hospitals, and stores and are even being permitted to sit in on the biweekly political discussions required of almost all workers in China. We are enjoying a view of China quite different from what I was able to observe last year; one that is probably unknown to all but a few foreigners.

The Lu Gou Chiao Jenmin Gungsha (Marco Polo Bridge People's Commune) is located a short distance from Peking. It comprises an area of about 18 square miles and a population of about 46,000 people, living in 10,700 households. This is not extraordinarily large; the Malu People's Agricultural Commune outside of Shanghai, which I visited last year, has 75,000 people.

Our commune is divided into 21 brigades subdivided into 143 production teams. The latter are the true functioning units of the commune; their members plan, work, discuss, and criticize together. They also share the problems and rewards of their joint agricultural effort.

My wife, daughter, and I are staying with a production team of 97 families. The team is closely knit, and in two weeks we have come to know many of the members. In addition to its primary agricultural activity, the commune manufactures farm tools, motors, lime, and bricks, and has facilities for the repair of trucks. Its children attend its own nineteen elementary and five middle schools under a Committee on Culture, Education, and Sanitation.

Each brigade is led by a Revolutionary Committee (RC), nominated and elected by its members. The Syau Tuen Brigade, of which our Mei Shih Kou production unit is a part, has an RC of nine members, one from each of its six component production teams and three chosen at large. Although only one of the RC members of this brigade is a woman, it was emphasized to us that the head of the commune itself is a woman, and that women play a large role in the commune as a whole.

When we arrived with our interpreter, Li Ming-teh, we were met by two leaders of the production team, a man and a woman. Chang Chung, a muscular man of 44, has had no formal education, but he is a skilled farmer and excels at getting along with people. He has six children, four boys and two girls. Chang Shu-men, a 27-year-old woman, is married, has no children, and is completely devoted to her role as a "responsible person" in the commune. We quickly learned to refer to them as "lao" Chang and "syao" Chang, for "old" and "young" Chang.

They led us to the home of our host, Shih Chen Yu, a 73-year-old patriarch with three sons and two

Commune by Arthur W. Galston

Before hanging them in the sun to dry, a woman braids garlic plants together. Behind her is a rabbit hutch.

A machine blows wheat into the air to winnow out the grain. Workers sweep up the chaff, which will be fed to pigs.

Cucumber vines have to be hand-tied to stakes. Vegetables account for two-thirds of this team's production; grain for one-third.

When tying rice seedlings into bundles, workers squat for hours. The author had to use a small stool for the job.

The commune has its own hospital, where herbs are stored in drawers at the pharmacy. Traditional Chinese, Western-trained, and "barefoot" doctors treat the inhabitants.

Classroom atmosphere appears rigid and formal. Students raise their hands, wait to be called upon, stand and recite crisply, and sit down promptly.

daughters. Two of his sons live and work on the commune in close proximity with their parents, the other son and daughter are millworkers in nearby Peking, and the youngest daughter is a teacher in the commune.

The extended family, 23 people, occupies a brick-walled compound of 90 by 84 feet, subdivided into an outer courtyard 30 feet wide by 84 feet long and an inner courtyard 60 feet wide by 84 feet long. Two 2-room houses, each about 21 by 40 feet, form an L at one corner of the inner court. At the opposite end is the toilet, a walled-in "one-holer" of concrete, open to the sky. Family waste is collected regularly and allowed to ferment for two or three months in an airtight concrete tank. Then, odorless and disease-free, it is used for fertilizer, especially on the vegetable plots, which are the primary concern of this production team. The remainder of the periphery of the inner compound is occupied by cooking sheds, storage sheds, rabbit hutches, chicken coops, and a small vegetable plot.

Near the houses in the central courtyard is a hand-operated pump in almost continual use, which yields large quantities of apparently pure fresh water. Water heated on coal stoves is brought to each house in a kettle, and stored in insulated jugs to provide abundant hot water for tea making or washing up.

The courtyard floor is earthen, but there is one concrete path down the center to the main house. This courtyard is swept and sprinkled frequently and is as scrupulously clean as conditions permit. The outer courtyard has an enclosure for a pig at one end, flanked by a shelter for a tethered sheep and her lamb and a pile of storage wood. The corners near the entrance to the lane contain a pile of coal and a pile of straw.

The house in which we live is divided into two rooms, one about twice as long as the other; about one-third the area of each room is given over to an elevated k'ang. This is an earthen bed platform built over a heating unit. It is covered by straw mats, sometimes also by rugs or thin mattress pads, and affords a spacious and comfortable, if firm, bed. The pillows, stuffed with chaff and covered with a finely woven straw mat, are also surprisingly comfortable.

Our days start at about 4:30 A.M. Fires are rekindled, water boiled for tea and wash-up, and children tended to. By 5:00, we are washed and dressed and sipping tea outside in the courtyard. Seated on low footstools around a low, square table, we are frequently joined by our hosts, interpreters, or lao and syao Chang. By 5:30 we are off to work, which moves at a good clip until breakfast at 7:00 A.M. At this time, the community loudspeakers, which have been playing inspirational music, switch to the news. Breakfast, rest, and true wash-up follow until 8:30, when work recommences and continues until noon with a break between 10:00 and 10:30.

Lunch is the big meal of the day and is followed by a long rest in the heat of the day, until 2:30 or 3:00 P.M. Then work continues until 7:00 P.M., with a break from 5:00 to 5:30. It is a long, hard work day, but always sociable, never frenetic. During the busy harvest period, some workers return to the fields after the evening meal, served at about 8:00 P.M. But we fall exhausted into bed at about 9:00 or 9:30 every evening.

We share a fair sampling of the work of the commune, which in the case of our team is two-thirds vegetable and one-third grain production. We tie up and weed cucumber plants, harvest beans, debud tomatoes, remove and bundle rice seedlings for transplantation, haul harvested wheat to the thresher, pitchfork the once-threshed material into piles for further winnowing, cart chaff to the piggery, gather the straw into stacks, sweep the grain into giant piles, shovel it into bags, help haul the bags to the warehouse, and sweep and tend the large, open threshing area.

We are finding muscles that we haven't known for years and marvel at the strength and endurance of the men and women who work the fields constantly. Their labor is continuous, graceful, and cheerful, and frequently accompanied by much chatter and ribbing and music from the community loudspeaker. We especially respect their ability to squat on their heels for hours on end without fatigue; we can last only about five minutes, and in harvesting beans and removing rice seedlings, this is a distinct disadvantage.

Our reaction to this hard work regimen after one week surprises us. We are exhilarated by it; we enjoy working together with a group engaged in a mutual, productive effort. We find our appreciation for small things, like tomatoes and cucumbers, heightened by our familiarity with the problems associated with their production. We also feel that the distressing problems of the world, in which we were so recently immersed, have receded and that what is really important is getting the wheat harvested before the rains come, getting the vegetables irrigated before the drought damages them, and increasing the welfare and happiness of our friends on the commune. In short, the brief exposure has worked; we are hooked and have become truly emotionally attached to the commune.

Each production unit has several "barefoot doctors," that is, regular workers who have received from one month to one year of special medical training. They can administer first aid, dispense routine prescriptions, assist at childbirth, and handle some inoculations and small surgery such as stitching up a wound. Each brigade (about six production teams) has a clinic staffed both by regular and barefoot doctors; the regular doctors can be either Western or traditional Chinese trained. Each clinic building has rooms for examinations, inoculations, minor surgery, and a pharmacy. It is open, with someone on duty, 24 hours a day.

The commune operates a large hospital, complete with all modern medical facilities and a staff of doctors, including Western, traditional Chinese, and barefoot. It is prepared to handle all but the most serious medical emergencies, for which patients would be sent to nearby Peking. Under this system, all commune members receive complete medical care for the sum of 2

73-year-old Shih Chen Yu feeds boiled vegetables to a pig in the courtyard. A sheep and its lamb were kept tethered nearby.

yuan (roughly 80 cents) per year.

Both my wife and daughter developed colds during the third day of our stay, and in my wife's case the complications of coughing and fever were enough to warrant some medical attention. So we were visited by a team of four medical people: a Western-trained doctor, a traditional Chinese doctor, and two barefoot doctors, all whom had a hand in the diagnosis.

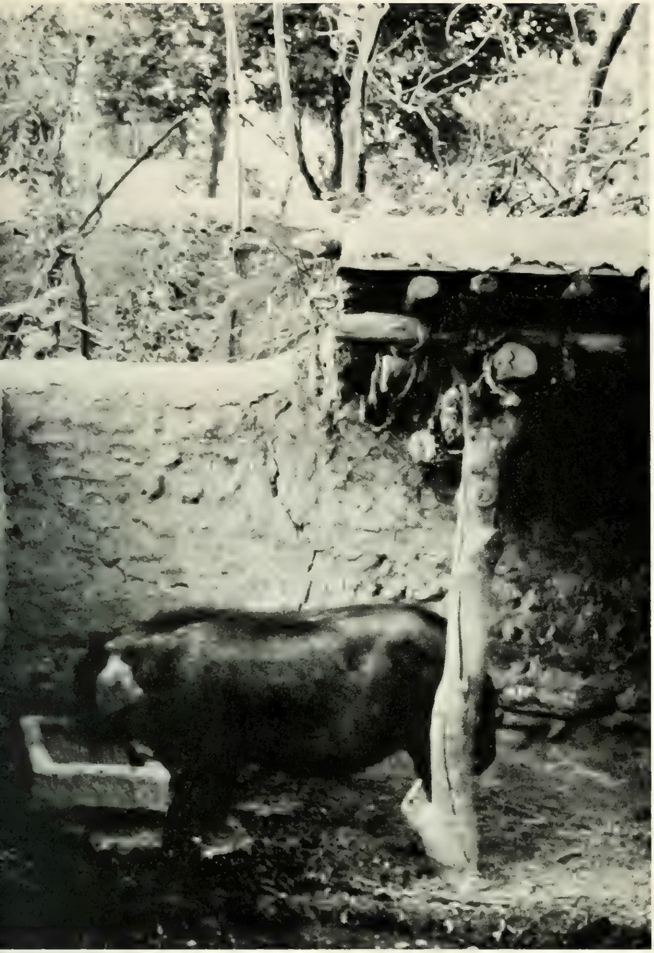
The traditional Chinese doctor, the senior member of the delegation, started the proceedings by taking my wife's pulse and then telling her that she had a cold, her throat was dry and sore, her stomach was upset, her head hurt, and her joints ached. He was right on about 80 percent of these statements, but he didn't ask, he *told*.

Then the Western-trained woman doctor took my wife's temperature, blood pressure, and pulse, looked inside her throat, and listened with a stethoscope at various spots front and back. She ended by palpating the abdomen. Both doctors then consulted with each other and the barefoot doctors and jointly wrote Chinese- and Western-style prescriptions, both of which were promptly filled and delivered to our house. This treatment was probably rather special, because we were foreign visitors and VIPs, but it was impressive nonetheless. Whether because of the treatment or because of the passage of time, my wife rapidly improved.

Furthermore, it does seem that all commune members feel secure medically, no matter what the emergency. This notion is reinforced when we hear many older members refer to the preliberation era when no peasant could expect medical attention for any illness.

Schooling, too, is self-contained within the commune, with each brigade operating one or more primary schools, and the commune operating the lower and upper middle schools for all. The primary school we visited has slightly over 500 students and 22 teachers, 7 male and 15 female. The teachers (usually more than 20 years old) are themselves graduates of upper middle schools and have studied some educational technique and a special subject. Their salaries are in the 50–60 yuan per month range, the median for workers generally. The school is governed by a three-man Revolutionary Committee under the close supervision of the Communist Party. The chairman of the RC, for example, is secretary of the local party branch, and the vice chairman is also a party member; the third member is a teacher. Yet we were told that these three are all chosen by election; we still cannot resolve this logical inconsistency.

The students go to school from 8:00 A.M. to 11:45 A.M. or from 2:00 P.M. to 5:45 P.M., double sessions each divided into 45-minute periods. During the first three years (ages 7–9) they study Chinese literature, mathematics, music, sports,



go on to upper middle school in this area, the remainder must go to work. The lower middle school we saw was an impressive red brick building on a large piece of land containing extensive athletic fields. It was founded in 1968, in the midst of the Great Proletarian Cultural Revolution, and already enrolls about 1,000 students in twenty classes with 43 teachers and ten staff members. Almost all students are from peasant families.

This lower middle school is run by an RC of nine members nominated "by the masses," whose election, after discussion, is approved by the Party Committee of the People's Commune. We were told that no nominated individual was ever disapproved by the Party Committee and that no person who had failed to be nominated ever complained or tried to run on his own initiative. The teachers are chosen by the Revolutionary Committee of the commune and the books are supplied by the Educational Department of nearby Peking Municipality. Courses offered include Chinese language and literature, mathematics, physics, chemistry, agriculture, politics, history, geography, foreign languages (seventeen English classes and three Russian classes), music, painting and drawing, and physical education.

To go on to the upper middle school, students must be recommended. Selections are made first by the students, then by their teachers, and final approval, as usual, is given by the Revolutionary Committee. There are examinations and grades, but we were repeatedly assured that there is no competition; students aid one another and special attention is given by the group to those having difficulty.

We visited a chemistry class in which a spirited and able woman teacher was explaining solutions, solvents, and solutes to an eager and attentive class of 48. After laying out the basic principles, she posed questions. Students responded by raising their hands, speaking loudly and clearly, and sitting down smartly after completing their answer. By contrast, the English language class was stiff and formal, and the stories in the readers were

drawing, and politics (largely Maoism). During the second three years (10–12), the program is extended to include industrial knowledge (practical work on the commune or at nearby factories) and "fundamental knowledge," which we gather is a general world view.

We visited an abacus lesson in a fourth-grade arithmetic class, which seemed well run and lively, though quite strict and rigid by our standards. The teacher had firm control of his 36 students, who raise their hands, wait to be called upon, recite crisply, and sit down promptly. We also witnessed tumbling on the athletic field, group singing in the music class, and reading aloud and a question period in the literature class. This modest building, in which many of the rooms have dirt floors and peeling plaster, is producing a well-drilled and educated youth, but there is much political indoctrination, uniformity of thought and action, and little allowance for individual divergence from the norm.

All primary school students go on to the lower middle school, which engages them until age 15–16; about 20 percent of the lower middle school graduates can

propagandistic, nationalistic, and frequently anti-American.

In the courtyard, we witnessed vigorous basketball, Ping-Pong, volleyball, and gymnastics. While competition between opposing teams was keen, it was maintained in a spirit of friendly rivalry. The major problem of this new school, according to three members of the Revolutionary Committee that we interviewed, is fulfilling the requirements for cultural reformation set by the Great Proletarian Cultural Revolution. To help adequately train teachers for this task, special seminars are held during the summer months.

Our over-all view of the elementary and middle-school facilities we visited was complicated, and, in fact, my wife and daughter reacted in one way and I in another. While all three of us agreed that the extension of universal education to age 16 is bound to raise literacy and increase skills and further educability, we differed on the effects of the strict rote learning and political indoctrination from the earliest ages. My wife and daughter felt that the children, taught unquestioning reverence for their "great leader and helmsman, Chairman Mao," would have limited desire and ability to deviate from any political or ideological line handed them in the future. If the successors to Mao and Chou En-lai turn out to be aggressive leaders out for world conquest, such regimented children could turn into willing and obedient soldiers, willing to follow wherever they were led.

While I acknowledge that these are real dangers, my experience with university people leads me to believe that their early training had damaged neither their critical faculties nor their ability to look at their leaders and party in a realistic light. Which of these points of view is more correct is impossible to say now, but the years immediately ahead ought to give us hints. I am also struck by the fact that even in a relatively open society like our own, the military forces can find enough soldiers willing to fight and bomb in Indochina that our operations there have continued for more than a decade, even in the face of determined opposition on the part of a growing number of citizens and congressmen. Thus, I feel that the danger lies, not so much in the early education of the children, but in the policies of the leadership of the country.

Rounding out the self-sufficiency of life on our commune is a line of shops near the schools. They offer foodstuffs, cloth and notions, agricultural implements, stationery supplies, and some toys. A commune worker receives an average of 500 yuan per year in addition to almost all the food he needs (some grown in his private plot). His living quarters and utilities are virtually free, and medical care and education are almost without cost, which enables him to use the better part of his allowance for the purchase of clothing, bicycles, household utensils, wristwatches, fountain pens, electric fans, and transistor radios. Since almost all adults and mature teen-agers, both men and women, work and receive salaries, the family income may well exceed several thousand yuan per year, much of which is saved or spent for consumer goods.

In China, there is no income tax or sales tax and no internal or external debt; the government gets all its income from the controlled price structure. A government agency buys all farm produce from the communes and then sells it at a sufficient markup to guarantee receipt of the differential required to sustain governmental operations. This system must employ a small army of economists, but it seems to work well. Prices in China are stable, the people have access to all the necessities of life, and the government is able to function and to improve life by construction of public works, housing units, roads, railways, etc. (During our overnight trip from Shanghai to Peking by train, the punctuality and cleanliness of the train, plus the cheerfulness and efficiency of the employees, made us feel that Amtrak should send some observers to see how they do it.)

In the matter of income distribution, individual differences are both recognized and rewarded. Each production team shares the fruits of its labor; thus, two production teams growing the same crops on the same commune may earn quite different returns for their labor. Within each production team, outstanding workers receive more production points than less able workers. Thus, within

Winnowed wheat is loaded into sacks. Most will be distributed directly to homes, according to each person's allocation; some will be stored in a warehouse.

this system of total communal ownership of the productive process, there is adequate incentive for individual initiative.

Entertainment, too, is provided within the hardworking communal regime. There are mobile movie teams, traveling actors, acrobats, and musicians, and "home talent" activities. As we work in the fields or take a break, we find the workers eager to exchange songs with us. Especial favorites with them are "Old MacDonald Had a Farm" (they crack up on the animal imitations), "Yankee Doodle," and "Clementine." We have also introduced several brightly colored Frisbees with great immediate success, especially among the boys and girls.

So, there is our commune—outside Peking in China—an incredibly hardworking, cooperative assemblage of dedicated people, sharing all the worries, plans, and profits of a collectively run, diversified enterprise. They enjoy levels of health, security, and material rewards undreamed of just a generation ago. They sense their growing prosperity and power. They support their present regime enthusiastically and virtually unquestioningly.

And in this resides the one aspect of life on the commune, and in fact in all China, that deeply disturbs us—this complete control of all that is taught, learned, and read. The news gives a partial, slanted view of the outside world. School routines foster rigid adherence to one point of view. Social or political deviation is met with criticism, usually followed by public self-criticism and frequently an enforced "re-education" process. The pressures to conform are well-nigh irresistible. What is this doing to individual mentality, creativity, and basic happiness? It will take many more months of experience in China before we can begin to analyze problems such as these.

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Above the Treeline

A sudden storm is never out of season on the alpine tundra

by Ann Zwinger and Beatrice Willard

To the east of Mount Evans are the high plains of Colorado, drawn in pastels and smudged as if with one long thumbstroke. In between are soft, morning-blue foothills, as rough and muted as a torn blotter. Clouds still catch in the valleys, remnants of yesterday's storm, lost sheep left behind when the flock moved out. To the west, the continental divide forms a choppy sea of jagged white peaks, serrating the horizon as far as one can see. A concatenation of cirques—huge, silent amphitheaters filled with snow—pockmarks the mountainside. A dotted white line of clouds is already forming over the divide, marking it just as a dotted black line marks it on a map of Colorado.

The temperature at 14,000 feet is 38 degrees, and the July morning breeze is chilly. A beginning-of-the-world quality pervades the alpine tundra landscape, a sense of sparseness and lucidity not unexpected in a vegetational zone that starts where the trees end and ascends more than 3,000 feet to the mountaintop. It seems strangely empty, and one is overwhelmed by the sharp contrasts and incredible intensity. A brilliant sky stretches on forever, and the flowers are miniscule references to their lowland relatives. The only objects larger than small are boulders. There are no trees to provide a measure of

height, few houses or other man-made objects to lend scale. There are no in-betweens, and for humans, who live in an in-between-sized world, comprehension takes time.

The light further confuses one's sense of scale. Faraway mountains are so sharply outlined that they seem much closer than they are. There is twice as much ultraviolet radiation and 25 percent more light here than at sea level, making sunburn cream and sunglasses necessities. The reflection of light off snow in the winter can damage vision, producing snow blindness. And psychologically, the light illuminating the alpine tundra gradually gives one a sense of revelation verging on euphoria.

Although it is July, new snow from yesterday's storm, extremely rare in midsummer, lies opaque and white between the weathered granite rocks at my feet. The temperature is about 30 degrees cooler than in the foothills, easily making the difference between rain at 6,000 feet and snow up here.

Generally the storms that coat the alpine tundra from late March into early summer are upslope storms, characterized by a local weatherman as "weather in the weeds" because visibility is reduced to nothing. These storms are formed when maritime, subtropical air from the Gulf of Mexico is pulled northward to the mountains by the low-pressure areas that frequently form in northern New Mexico. When the wet winds back up against the east face of the Rockies, we are in for heavily overcast days. At lower altitudes it may rain, but when the moist air extends up over the continental divide into higher elevations, the mountains can be smothered with snow: in April of 1921 a record snowfall of 76 inches in 24 hours was recorded for this area.

Upslope storms are usually gentle and persistent, sifting down moist snow. They come like a benediction, with little wind and generous moisture, clinging to the land and seeping into the thirsty tundra soils. In contrast, winter blizzards come slashing out of the north and west, dry and sharp, blowing the snow off almost as fast as it falls.

But as I walked up to the summit on that July morning, the newly formed snow crystals were crisp and exquisite. In the warmth of summer, however, they soon lost their spidery tracery and metamorphosed into rounded granular particles. As the delicate branches of the crystals disintegrated, they slid together to become a closely packed layer of amorphous grains.

A southeast-facing boulder was coated with clear ice, but beneath the ice, running water made dark droplets, like little tadpoles racing downslope, catching each other in continuous arabesques. Boulders, lying below snow patches, shone with slender serpentine slivers where water plaited downward, the dull rock enlivened by the quicksilver sparkle. Seepage down the granite was so slow that there was no glisten, just a change in surface color that said "damp." At the top of the watery trail, a pika—alert and wary, a little handful of an animal—sampled the morning breeze. As soon as it heard a footstep it piped its distinctive warning and popped off its sentinel station, disappearing among the rocks.

On the summit, not even a fly is about yet. The rocks are firmly encased in ice, and there are still frozen puddles in the hand-sized depressions on their tops. Three small puddles in a descending row hold a spattering of lichens. Entrapped air bubbles radiate out from the center of the ice, tracing tiny dotted white lines. A five-inch ice handle on the bottom puddle points due northwest, making a transparent sundial. But it is an evanescent timepiece due to disappear this morning, while the rock remains unchanged, telling time in centuries, not hours.

Snow and ice are always part of the western alpine view. The jagged profiles of these mountains are white in winter, and bear vestiges of snow all summer. The glaciers that carved and sculptured their flanks during the Pleistocene left many alpine areas untouched, as here in the eastern Rockies, high above the ice that wedged through the valleys thousands of years ago, but the cold and dampness have marked these areas as clearly as the glaciers marked the lower landscape. Much of the alpine tundra is more rolling and gentler than one expects above treeline. It has a well-scrubbed, worn look, like an old tabletop once painted nicely green, now warped, faded to a patina, chips of paint remaining only in the cracks. This flowing surface has been smoothed by different types of frost action, all of which work to level high mountain surfaces. The high alpine ridges surrounded by, but not covered with, glaciers were especially subject to frost actions during the colder, wetter climate of the Pleistocene.

Permanent moisture, together with a certain temperature pattern, depends upon and creates permafrost. The combination of permafrost overlaid by water-saturated soil provides optimum conditions for the freeze-and-thaw phenomenon common in both arctic and alpine regions. Rocks are heaved out of the ground, forming polygonal patterns; soil, thawed and saturated, creeps downslope over a firm underlayer of bedrock in a process known as solifluction. In marshy areas, frost hummocks, green with lush sedges and mosses, alternate with near-empty black bog soil.

The continual freezing and thawing of water eventually fractures all bare rock surfaces, and as fragments fall away, new layers are unsealed and opened to weathering. Over the millennia, bedrock is progressively broken down into smaller and smaller particles until gravel and sand are all that remain.

Gently curved solifluction terraces lie across the slopes on which they were molded. Such wet soils are extremely unstable. Solifluction is a slow process, but over the centuries it moves enough soil downward to round off the uneven landscape. Old, inactive solifluction terraces are revealed in the subtle undulations of the vegetation characteristic of many cold regions.

As ice forms in the wet soil, the soil's volume increases, creating pressure on the loose rocks within and eventually expelling them. Sometimes they form the patterned ground found in nearly all tundra areas. The patterning is as precise as if drawn for a textbook illustration: long rock streams flow down or drape across the slope, pulling

an alpine winter. Small snowdrifts form between the hummocks in early fall, but the higher tops, left free of snow and exposed to wind, are subjected to freezing and drying. Several dead and desiccated plants hold to the soil by a root thread, ready to fall away with the first tug.

When plant cover is finally torn away, needle ice crumbles the soil, which is soon blown away by winter winds. After the insulating top layer of soil is removed by wind erosion, the permafrost beneath the hummock retreats. Surface water penetrates deeper and frost heaving is accelerated, creating a scar through which buried rocks are pushed up and out. Extruded stones tumble down the sides of the convex center. Eventually, the center of the hummock, wind-eroded and bereft of rocks, becomes low and level, an area of fine materials ringed by the ejected rocks.

Plants insinuate themselves into the edges of these rock rings, which are more stable than the still-active centers of the frost scars where roots and rhizomes are torn. As soil

On the high, rugged peaks of the Colorado Rockies, "the flowers are miniscule references to their lowland relatives."

into garlands where the grade steepens. Huge polygons are formed, often with smaller patterns within. Old patterns are frequently buried in alpine meadows by the buildup of soil and the thick growth of meadow grasses and sedges.

Frost action is most apparent in wet ground. Tiny patterns of pebbles and small rocks tile seep areas. Over a period of time, hummocks, ranging from teacup size to that of a large pillow, are raised across an alpine bog. Some of the hummocks are low, while others have been elevated by frost heaving, which lifts their plant cover out of the thin winter snow blanket of the marsh into the murderous environment of

The snow-filled cirques of Mount Evans are reminders that "winter is never more than six weeks away."

begins to build up over the rocks, other plants are able to invade. The vegetation begins to insulate the scar center, frost activity decreases, and still more plants colonize the middle of the scar. When heaving subsides altogether, plant cover becomes almost total.

Like snow, wind is a constant presence on the alpine tundra. On top of a ridge, it blows across, swooping up from the dark green valleys below. There is something about an alpine wind: it seems to come from the back of beyond, carrying tangles of trees in its passing. In the mountains, its average velocity increases with height above ground. It erodes soil and nudges turf until "wind scarps" are carved out. It dictates the shape of plants, scatters seeds and pollen, distributes lichens that reproduce by fragmentation, and molds the snow surface into fanciful sculptures.

Wind distributes snow, the most important dictator of plant communities in an alpine region. Under the snow, plants are protected from the wind; above it, they are pruned back. In snow-free areas, entirely different plant communities develop, which are adapted to water desiccation. The prevailing winds move clouds rapidly across the sky, constantly altering light values and bringing the afternoon storms and clouds frequent in alpine areas.

When the wind is strong it carries sand and snow and has considerable abrasive effect at the ground surface, pitting and sculpturing rock outcrops on the windward side and sandblasting bark and twigs. If water is not available to plants at these times, either because the soil is frozen or because of insufficient moisture, strong ground winds cause plants to wilt as if under severe drought. Wind is most lethal in the winter when it shears off all exposed growth.

On a cold day at high altitude, the combination of wind and low temperature has the same physiological impact on human flesh as much lower temperature under calm conditions, making high-altitude work hazardous. Wind velocities are the greatest in winter and spring. In the winter they make working conditions above tree limit difficult, demanding not only special equipment and clothing but also extreme self-discipline and stamina. In the spring, warm chinook winds often reach gale velocity; like a blow torch, they evaporate the snows of eastern mountain slopes.

Since wind speed and pressure increase with height above ground, the environment is colder and windier at man's height than at plant level. The difference can be discerned by lying prone and becoming part of the plant world; indeed, sometimes this is the only place where one can work comfortably. The wind still twitches and frets the grasses at eight inches, but scarcely nudges the smaller cushions and mats at two inches.

It is at this myopic level, where sedges fringe the far view like green eyelashes, that one feels much of the enchantment of the alpine tundra, and there is a real reluctance to go down at the end of the day. I find as many excuses as possible to prolong the descent. The next outcrop catches my attention. What small plants grow in its shelter? A glimmer of water across the slope piques my curiosity. I walk to it and explore, finding tiny pink alpine willowherbs and deep-blue speedwells studding the margin of a tiny pool caught behind a solifluction terrace.

The sun disappears as I poke around the outer edges of the pond, and I take off my backpack to get out a down jacket. The wind is suddenly chill and sharp. I have foolishly miscalculated the alpine weather, forgetting in my concentration the caprice of its clouds and the swiftness of its tempers.

Toward the east the plains are still sun-bathed. To the west a mountain storm, like a hand across the sun, shreds over the peaks. Lightning flashes and I automatically begin to count, "One thousand one, one thousand two, one thousand three, one thousand four," hoping to get to the seven that means the strike is a mile away. Thunder rolls down the valley; the strike is less than half a mile away, too close for comfort.

The cirque I find myself in soon gathers the direct blast of the storm and piles it up against the surrounding slopes. Within the natural amphitheater, wind swirls like a dervish, snatching off my hood, and raindrops begin hitting with the force of hail. Then graupel—a kind of half-snow, half-hail—drives horizontally, stinging my face like hurled gravel. It whitens the ground and dances off the rocks. My hands ache with the cold, and I cannot see ten feet in front of me. Snow and sleet smoke all around, and I have grim thoughts of death by exposure. I think of things I wish I had told my children.

Lightning detonates again. A human on the treeless tundra is often the highest object and therefore a lightning attractor. Sighting the wall above me, I hope that I am within a 45-degree angle from its top to the ground. Any direct hits in the immediate vicinity should be "caught" by the rock wall, protecting a conelike area at its base; but, to be safer, I crouch down on a narrow ridge of dirt within a cluster of slightly higher rocks. I shove my backpack under me for balance and insulation, and hunch to form the least possible lightning focus. My heart pounds against my knees.

Lightning and thunder seem to hit simultaneously—I hear the lightning bang and feel the percussion of the thunder. I discipline myself and make a visual check of my surroundings to be sure I've avoided a damp gully that carries ground current, the discharge of lightning that travels through damp soil. I take care not to touch the rocks so that I do not conduct current from them. Ground currents can be strong enough to make rocks buzz and one's muscles twitch.

Looking at the crevice plants within the few square inches of vision, I try to reassure myself with the physical reality of their survival. The tiny furred cushion plant, which is adapted to take advantage of minimum warmth and moisture, is anchored by its deep taproot. A wolf spider hies to safety beneath it. I envy the pika, tucked safely behind a boulder, able to survive on the herbs and grasses of the tundra summer. Everything that lives here is adapted to survive the elements. I am not.

The hail and rain stop as suddenly as they began, and a shaft of sunlight fingers a distant peak. I stand up and brush myself off, drier than I expected to be, a little stiff but very much alive. Every flower and grass quivers in the wind and shakes itself free of the weight of the water drops. One by one the stems spring upright, shaken by the fresh breeze. The sunlight catches each drop of rain still pendant, and even the rocks glitter in the brilliant crystalline light. I feel a primitive sense of survival, a renewed and refreshed sense of living—and considerable relief that the storm is over. I feel like running across the slope, but one who dashes across this rocky terrain is both foolish and winded, and might miss something. I walk sensibly back, seeing in every windrow of graupel and white parenthesis of hail that snow is eternally a part of the alpine world, and that winter is never more than six weeks away.

The constant wind sandblasts bark and twigs, pruning back any trees colonizing the alpine tundra of the Colorado mountains.

Survival on a Bleak

When winter drains its energy, the redshank hunts all day and night, on shores and fields, for the 40,000 bits of prey it needs to live

by John Goss-Custard

On the northeast coast of Scotland, about ten miles north of Aberdeen, the river Ythan forms a protected tidal estuary just before it reaches the cold, stormy North Sea. A sandy peninsula with low dunes separates the estuary from the sea. It is a wildlife sanctuary, and the shores and surrounding waters are a haven for large flocks of shorebirds and waterfowl.

Long-legged oyster catchers and redshanks, another common European shorebird, are often seen striding along the beaches and tidal flats. Because the behavior of the redshank presents a number of difficult but fascinating ecological puzzles, I have studied this bird for years.

During a year, the redshank feeds on a variety of prey in the nearby fields and on the estuary. Yet at certain times and seasons the bird feeds in only one area, ignoring other, apparently good feeding conditions. And it may feed night and day or only during the day. Why?

A bird population often appears to have a variety of ways to collect food from its environment, but it may use only one or two of these options. On the basis of the theory of natural selection, the bird would choose the most efficient feeding strategy. That choice would be decisive to its survival. In theory, then, the behavior of the redshank—flying between field and estuary, scattering in irregular flocks along the shore, eating or resting at night, striding along, feeding from side to side—is the best way for the bird to exploit its broad environment.

This raises the question, What is efficient behavior for a whole population of birds—or for any other animal? Part of the answer is that the method an animal adopts for exploiting the environment must enable it to collect sufficient energy to replace the energy it expends. Energy is used to maintain the body temperature and to carry out activities. Within the narrow limits of its energy reserves, an animal must take in a certain minimum amount of food to balance its crucial energy input/energy output budget.

Generally food is not scarce at all times of year; there are many periods when an animal has no difficulty in finding all the food it needs. But even during bountiful times we expect birds to feed efficiently because the less time the bird spends feeding, the more time it can devote to other essential activities. These would include maintaining its plumage, keeping alert for predators, and in the case of territorial species, competing with other animals for space. Furthermore, in the breeding season the efficient animal would raise a larger number of healthy young than would a less efficient rival because it can collect more food for its young and spend more time looking after them.

Therefore, an animal should feed as efficiently as possible at all times. A description of the bird's daily feeding activities will show how amazingly efficient it is.

The redshank is an attractive, medium-sized wading bird that stands about eight inches high, has dark brown upperparts, a slightly paler head and breast, and an almost white belly. Its long, strikingly colored orange-red legs give the bird its name. During the breeding season redshanks live both inland and in coastal regions on moors, marshes, and meadows; at other times of the year they mainly inhabit coastal regions, where they collect their food from meadows, marshes, and the intertidal zone. In winter the birds are particularly numerous on the muddier regions of estuaries.

Redshanks breed in Iceland, Britain, and in many parts of the continents of Europe and Asia. Most of them migrate southward in autumn after the breeding season ends. They are then found along the coasts of southern Iceland, Britain, western Europe and Africa, around the Mediterranean and eastward through northeast Africa, the Red Sea area, and on into the south of Asia as far as the Philippines.

My own work on this species was carried out on the small Ythan Estuary. While redshanks occur on the estuary throughout the year, they are far more numerous there from autumn to spring than during the summer breeding season. I therefore devoted most of my time to studying their feeding between August and April. At times during the study, up to 900 birds occupied the estuary, which is four miles long and never more than a few hundred yards wide. The large number of birds in this small area suggests that they were an important component of the estuarine biological community. The study contributed to a long-term research program on the estuary carried out by Aberdeen University.

At all times of the year redshanks feed predominantly on small invertebrates, using only one or two methods to find food. They generally walk over the ground at a rate of about twelve yards a minute and either peck frequently at the surface or probe deeply into it with their bills. They can feed on the surface at a very fast rate: I have often seen them eat sixty food items a minute. When they surface feed they apparently detect their prey by

Scottish Estuary

sight because they seem to scrutinize the ground as they search, often dashing from side to side to pick up prey. At other times they feed in an entirely different manner, walking very slowly and sweeping their open bills through patches of soft mud. When they do this, they apparently detect their prey by touch.

Like many birds, redshanks feed on a wide variety of prey. In farm fields they often follow plows, retrieving exposed earthworms and insect larvae. More commonly, they feed in grass fields, probing into the soil for prey. On the estuary the birds took nine different species, but only four of these were of real importance. These four invertebrates occurred in extremely high numbers—often as many as fifty thousand per square yard.

The most important prey was *Corophium,* a small, shrimplike creature that grows to about a third of an inch in length and lives in U-shaped burrows to a depth of about three inches. *Nereis,* a three-inch, segmented worm, burrows straight into the mud to a depth of about eighteen inches. *Hydrobia,* a small snail with a quarter-inch shell, lives in the surface layers of the mud. *Macoma* is a small, burrowing bivalve mollusk whose shell is about half an inch wide.

Because it was difficult to study redshank feeding in the dark, I put most effort into studying their daytime feeding activities. It quickly became clear that a whole series of factors affect the rate of feeding and the kind of prey taken.

If all the prey species were equally palatable and easy to locate and catch, the proportions of each species in the bird's diet would accurately reflect their densities in the mud. But I quickly discovered that things were not that simple. Certainly, the diet was influenced by the relative densities of the different species in the mud. In the upper reaches of the estuary, for example, the redshank took *Nereis* more frequently than *Macoma* because there the worm was more abundant than the mollusk. But there were generally several tens of thousands of the snail *Hydrobia* per square yard, while the bird's diet consisted mainly of *Corophium,* which was far less abundant and never occurred at densities exceeding eight thousand per square yard. Possibly some species were more difficult to find than others: the prey were all located in the mud and the birds often directed their pecks at cues too subtle for me to detect. Although *Hydrobia* frequently occurred in huge numbers clearly visible on the mud surface, the birds ignored most

of them. The small size of this snail may make it an uneconomical prey to feed on, or its thick shell may make it difficult to digest. At night, however, redshanks will feed on *Hydrobia* and, to a lesser extent, on one or two other species of mollusks.

Density and palatability of the prey were not the only factors that influenced the redshank. Climate had a great effect on the bird's diet and feeding rate. The temperature of the mud was one factor. At higher temperatures, for example, the shrimplike *Corophium* formed most of the food intake in terms of both numbers and weight. As the temperature dropped, however, complex changes took place, which varied from place to place and from season to season. In one winter the numbers of *Corophium* and *Hydrobia* taken per minute decreased drastically as the mud temperature dropped to freezing. At the same time the numbers of *Nereis* and *Macoma* taken increased.

The result was a complete change in the importance of the various prey in the diet: from being the most important at higher temperatures, *Corophium* became one of the least important at lower temperatures. This change in diet was probably caused by the effect of low temperature on the behavior of the prey. Anything that affects the visibility of the prey or the likelihood of its being near the surface would affect the frequency with which the birds encounter it. At higher temperatures, *Corophium* often stuck their front ends out of their burrows for a few seconds at a time. The number of animals doing this drops as the mud temperature decreases, so that at about 40 degrees Fahrenheit, none appear.

Rain also forced the prey deep into their burrows, and at the same time the feeding rate of the birds decreased by about 50 percent. In this case, however, the decline in feeding rate seemed to result from the mud surface being stirred up so that the prey became more difficult to locate. Both at low temperatures and in rain the birds still managed to collect *Corophium* at a fast rate, even though none were visible to me at the surface. What they actually pecked at is something of a mystery. It was a reliable indicator, however, because the birds usually managed to catch a prey in 70 to 80 percent of their attempts.

The redshank, then, searches over a carpet of prey that varies in density, size, availability, and palatability from place to place and from time to time. Two factors affect the diet and feeding rate. First, the density of the prey that the birds can actually locate and catch is of great importance. In addition, because the birds do not merely take all the prey they encounter, some selection is taking place. The principles underlying this selection process in birds are now important research topics for both ecologists and students of behavior. It is likely that both the nutritional quality of the prey and the amount of energy it enables the bird to collect per unit time and effort expended are important.

As well as having to choose between the various prey they encounter, redshanks also have to choose between the fields and the estuary and between daytime and nighttime feeding. In the spring and autumn they fed only during the day and mainly on the estuary. Throughout the night and at high water during the day they roosted in compact flocks at various places around the estuary, particularly on an island in the middle.

The daily feeding pattern was quite different in winter. First, during the day at low water they fed both on the estuary and in the surrounding fields. Second, instead of roosting at high water, the birds flew to the fields to feed. Third, all the birds returned to the estuary at night and fed there, except at high tide, when they flew to their roost. In winter the birds spent nearly all of each 24-hour period feeding in a variety of situations, while at other seasons they fed only during the day on the estuary.

The distribution of the birds between the estuary and fields at low water depended on the weather. The birds flew from the estuary to the fields when the temperature dropped and when it rained: hence, in winter most of the birds fed in the fields. However, in periods of severe frost, when the ground froze or when it was covered with snow, the birds returned to the estuary to feed.

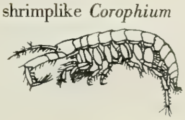
These changes in the daily routine of feeding produced dramatic seasonal variations in the diet of the population. In autumn most of the diet consisted of the shrimplike *Corophium* because the birds fed only on the estuary during the day and the mud temperature was high. In winter a varying number of birds fed on the estuary during the day, where the mollusk *Macoma* and the worm *Nereis* contributed a lot to their diet. They also fed on earthworms and insect larvae in the fields and on the snail *Hydrobia* at night. During the spring, most of the redshanks again took mainly *Corophium.*

What causes these changes—these dramatic shifts in diet—in the daily feeding routine in different seasons? First of all, in winter the birds require much more food each day than in autumn and spring be-

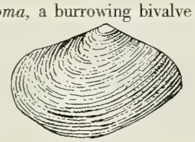
Main Prey of the Redshank

Nereis, a segmented worm

The shrimplike *Corophium*



Mycoma, a burrowing bivalve



The small snail *Hydrobia*

As water recedes on a tidal flat, redshanks search for prey. The birds cluster in areas where prey is most dense.

cause they have to take in a great deal of energy to keep their body temperatures constant. In winter the daylength is short and with the tide covering the mudflats for several hours out of every twelve, the birds that feed intertidally have only five or six hours for feeding on the estuary in daylight. As a result, in winter they are able to collect only 40 percent of their daily food requirements from the estuary in daylight even though they spend 96 percent of the available time feeding. Additional feeding at night and in the fields at high water is therefore essential.

By contrast, the feeding conditions are much easier in spring and autumn. The temperature is higher, so the birds need less food and prey are more available in the mud. The prey are also larger at these times of year than in winter and there is much more time in which to feed. As a result, the birds are able to collect all their food during the day on the estuary and do so by spending only 88 percent of the available time feeding.

The redshank's behavior raises further questions: Why don't the birds spread their feeding throughout the day and night in autumn and spring? What determines the preference between the feeding areas? The redshank evidently does choose the most efficient feeding situation. Feeding at night is apparently much less efficient than the normal daytime feeding because of the slow, probing method used. Presumably this is why the birds always prefer daytime feeding and feed at night only when they are forced to do so in winter. Similarly, the distribution of the birds between the estuary and the fields is correlated with the relative efficiency of feeding in the two habitats. Rain, for example, cuts the rate of feeding on the estuary by half, so the birds fly to the fields where they can feed on the abundant food supply provided by worms coming to the surface. Similarly, low temperature reduces the feeding rate on the estuary and again the birds fly to the fields where the feeding conditions probably are better.

But the best demonstration of the birds' preference for the areas that allowed the most efficient feeding

come from within the estuary itself. While the birds feed all over the estuary, some areas attract many more birds than others. I discovered that the density of the birds correlated closely with the density of their main prey, *Corophium.* Where the density of their prey was highest not only was the weight of food collected per unit time greater but also the amount of effort put into collecting a given quantity of food was less. While feeding, redshanks expended energy on walking and on pecking. The walking rates were similar in the different areas, but the number of pecks required to yield a given quantity of food was much less in the preferred areas.

Since some areas were clearly better than others, why didn't the birds all congregate in the few best areas? One possibility is that if the birds had done this they would have interfered with each other's feeding. *Corophium* shoot down their burrows when a redshank walks over them, so if large numbers of birds assemble in a few places, these would rapidly cease to be the best feeding areas.

An over-all picture emerges of the birds preferring to feed in the places and at the times of day that provide the most efficient feeding. This choice is made at all levels: within the estuary itself and, at an even finer level, at points up and down the beach. Finally, the kinds and sizes of prey taken are probably also partly determined by what can be most efficiently collected.

The fact that in autumn and spring the birds feed only on the estuary during the day, and do not spread their feeding throughout the high-water period and throughout the night as well, suggests that they prefer to complete their feeding as soon as possible. Apparently, the redshanks avoid the fields at high water and the estuary at night not because some factor, such as predation, makes these areas more risky, but because such feeding situations are less efficient.

Feeding efficiently was clearly of direct importance at certain difficult times of the winter. When there was snow in the fields the birds could not feed in this habitat. Furthermore, ice in the upper reaches of the estuary at these times often denied that important region to the birds. On the estuary, the low temperature reduced the feeding rate of the birds. The result was that after a few days, small numbers of birds died and many more left the area and did not return until the weather improved.

Winter may be a difficult time for many bird populations. Quite apart from the hardships inflicted by periods of snow and ice, the low temperature in winter produces high energy requirements and these may be difficult to meet because the prey may be scarce. Furthermore, if the bird can feed only during the day, the short period of daylight during winter restricts the time available for finding food. This can give rise to incredibly high rates of feeding: European tits require an average-sized insect every 2½ seconds of the day to keep alive! Similarly, redshanks on the Ythan Estuary have to collect about 40,000 prey items a day to survive, but because they can locate their prey by touch in the soft mud, they can feed during the night as well as during the day. Although night feeding is relatively inefficient, it is essential to the birds if they are to survive the winter.

Thus, the redshank, along with all the other species of birds on the Ythan Estuary, pursues an efficient strategy of food gathering. Depending on the season, the climate, the hours of daylight, the tides, the action of its prey, and many other factors, the bird selects the most efficient time and place and foraging method. In theory, the redshank must behave this way to survive, yet this in no way makes less remarkable the bird's feat of finding 40,000 items of prey every 24 hours during a harsh winter in Scotland.

Summer permits redshanks (foreground) and oyster catchers (at right) time to roost. In winter, redshanks feed most of the time.

The Minoan Connection

Out of their mysterious past, the spirited sealords of Crete emerge as a vital link between Egyptian, Greek, and Hebrew civilizations

by Cyrus H. Gordon

Greek authors, including Homer, Herodotus, Thucydides, Plato, and Strabo, knew of a great, pre-Hellenic empire of Minoan sealords centered on Crete. But it remained for the British archeologist Arthur Evans, who had faith in the traditions, to unearth the material remains of the Minoans. In 1900 at their main capital, Knossos, near what is now Herakleion, he found clay tablets with Minoan writing, thus providing the means of transforming the Minoans from a prehistoric to a historic people.

We now know that Minoan palaces and inscribed tablets first began to appear on Crete about 1850 B.C. There had been, to be sure, an earlier population on the island, but excavations of their communities do not reflect the high Minoan civilization that flourished there between 1850 and 1400 B.C.

Who were the newcomers who produced the palaces and the archives? The architecture of the palaces suggests that the newcomers came from a warmer climate to the south. Minoan emphasis on air-and-light wells and the absence of built-in hearths did not make for comfort on the raw winter days of Crete. The most likely southern land is Egypt, for Egyptian imports

A woman, above, known to archeologists as "La Parisienne," and a youth carrying a drinking vessel, opposite page, are depicted in frescoes from the Minoan palace at Knossos. The paintings are believed to date from about 1475 B.C.

A side view of the painted limestone sarcophagus from the palace site at Hagia Triada, ca. 1400 B.C., shows, at right, three men bringing a boat and two calves to the deceased, who stands beside his tomb. On the left, women carry fluids in elaborate vessels. In Minoan art, men appear ceremonially colored reddish brown, while the women are white. This difference between men's and women's cosmetics is also found among the Ugaritians, Hebrews, Egyptians, Etruscans, and several other peoples.

are abundant at Minoan sites. Egyptian inscriptions on Crete, especially those with Pharaonic names, provide the primary basis for Minoan chronology. There are Eurasian artifacts, as well, including Babylonian seal cylinders (when rolled on soft clay tablets, they left convex impressions identifying the owner), but the archeological record indicates that Egypt made the strongest impact.

The main single feature of the Minoans was their thalassocracy: they were sealords. Strabo states that they undertook longer and bolder voyages than the later Greeks and Romans. Their heyday (1850–1400 B.C.) was contemporary with megalithic structures in the Atlantic community, notably Stonehenge in England, where ancient carvings of a "Mycenaean" dagger and double axes, as well as burial mounds that contained Egyptian blue faience beads, are among the links with the Mediterranean of the mid-second millennium B.C.

Eleven colonies around the eastern and central Mediterranean had the epithet "Minoa." For instance, Gaza is so identified by a coin with the legend "Gaza Minoa." Another "Minoa" lay east of the Dead Sea along a route to a Red Sea port. Its location made sense as a Minoan station for maintaining trade on the Indian Ocean.

The Minoans were sea people whose familiarity with marine life is reflected in their art. The octopus, portrayed realistically at first, but becoming highly stylized with the passing of time, was a favorite theme. Various fish, including flying fish, are portrayed with verve. The appeal of Minoan art, as distinct from the more sedate and static arts of Mesopotamia, Egypt, and classical Greece, is precisely its liveliness. The frequency of spirals instead of straight lines, a bull shown in a flying gallop with all four feet off the ground, and young men and girls pictured vaulting in mid-air over a bull, illustrate the Minoan's love of activity.

The architecture of the main Minoan centers, such as Knossos, Phaistos, Mallia, and Kato Zakro, is agglutinative: units were added to form a growing complex emanating from the palace. On the Asiatic mainland we find related architecture at such sites as Alalakh in southern Turkey, and even distant Mari on the middle Euphrates.

Although ancient buildings are not as a rule preserved to a great height, we have Minoan representations of houses with upper stories and windows. In Ugaritic literature (from the north coast of Syria) of the Late Bronze Age (1600–1200 B.C.), the window is regarded as a

Minoan innovation introduced by Kothar-wa-Khasis, the Cretan god of arts and crafts, who was invited to build a palace for the god Baal. The Ugaritic text says of Kothar-wa-Khasis that he resides on Caphtor (Crete), but the land of his inheritance is Egypt. This implies that while Minoan Crete was then the cultural and artistic center of the east Mediterranean, the origins of Minoan art lay mainly in Egypt. Yet Minoan art is distinctive. This apparent discrepancy arises because there were two Egypts.

This fresco from the palace of Knossos, ca. 1475 B.C., shows successive phases of the cultic sport of vaulting over a charging bull. The athlete skillfully gets himself tossed by the bull's horns. Spanish bullfighting, which begins each year on Easter Sunday, retains some of the sacramental overtones of its indirect Minoan heritage.

The bull was worshiped throughout the eastern Mediterranean. This bull-head drinking vessel, partly restored, comes from the Zakro palace. El, the chief of the Canaanite pantheon, is also called "The Bull" in Ugaritic literature. In the unorthodox Hebrew cult of the Golden Calf we see a relationship between Crete and Canaan; both worshiped the Old Bull as well as the Young Calf.

The ancient Egyptians called their country Tawy, "The Two Lands," and the Pharaohs wore the double crown of Upper and Lower Egypt. Most of what we know about the material remains of ancient Egypt comes from Upper Egypt (south of the Cairo area or, in other words, "up" the Nile River); most of the remains of Lower Egypt (the Nile Delta) have perished because of intensive cultivation and destructive moisture. Unlike Upper Egypt, the delta region is a Mediterranean country with a mixed population. Ancient Alexandria, composed about equally of Egyptians, Greeks, and Jews, illustrates interethnic delta dynamism. Genesis 10:13–14 derives the Cretans from Egypt, which can only mean the Nile Delta. No other part of the country has the coast required by sea people.

We must seek the historic cause for the migration from the delta to Crete that touched off the building of the Minoan palaces. The Old Kingdom, which had produced the great pyramids, collapsed in the closing centuries of the third millennium B.C. That period of disintegration in Egypt is called the First Intermediate, when foreigners contributed to the internal breakdown of the land and its fragmentation into the old local provinces. During the early part of the second millennium, the local rulers of Thebes began the process of expelling the foreigners and reuniting the two Egypts to usher in the Middle Kingdom. The task was completed by the Twelfth Dynasty, just before the first Minoan palaces appeared.

The language of the Minoan inscriptions is, as we shall soon see, northwest Semitic. The Minoans were a people talented in navigation, trade, and art. They controlled a number of islands and coasts, but were mainly headquartered on the delta. The purge that expelled them was aimed at eliminating a creative element that was regarded as a threat to the purer Egyptians of Upper Egypt. Such purges always drain a country of its talented elite. Eventually (ca. 1670 B.C.), Egypt fell into its Second Intermediate period of decline, culminating in the foreign Hyksos dynasties. The Hyksos invaded Egypt from Asia and held sway over an international empire from their capital at Avaris on the eastern coast of the delta. The Hyksos empire had interests in Crete and in the Near East as far as Babylonia. We know this from sources, including stone objects inscribed with the name of the Hyksos Pharaoh Khyan, found as far east as Baghdad and as far west as Knossos. It is likely that the Minoans, mindful of their expulsion from Lower Egypt, supported the Hyksos in their conquest of Egypt, and remained their allies.

About 1570 B.C., the vigorous Eighteenth Dynasty of Thebes drove out the Hyksos and reunited Upper and Lower Egypt to inaugurate the New Kingdom, or Empire Period (ca. 1570–1200 B.C.). The fall of the New Kingdom went hand in hand with the expulsion of another talented northwest Semitic people from Lower Egypt: the Hebrews, who excelled in administration, trade, and art. The delta thus emerges as the breeding ground of both the Minoans and the Hebrews.

During the Late Bronze Age, the Mycenaeans coexisted with the Minoans, absorbed their civilization, and gradually supplanted them, so that by 1200 B.C. the Aegean was predominantly Greek.

At Knossos, Evans had discovered clay tablets inscribed in both Minoan and Mycenaean. While he could not pronounce the signs, he realized from the different word groups that they were in two different categories. What we now call Minoan, he called Linear A; what we call Mycenaean, he called Linear B. The same writing recorded two entirely different languages: Minoan, which is northwest Semitic and related to Phoenician, Hebrew, and Aramaic; and Mycenaean, which is a Greek dialect.

The Minoan inscriptions became pronounceable as soon as the Mycenaean texts were deciphered by the late Michael Ventris in 1952. We know that the same signs were pronounced identically because the same names are spelled the same way in both sets of texts. For example, the city name "Phaistos" is written *Pa-i-to,* and the personal name "Pade" is written *Pa-de,* in both sets of texts.

Different kinds of context enable us to define various pronounceable words, thus providing the means of identifying the Minoan language and translating the Minoan (Linear A) inscriptions.

One Minoan tablet from Hagia Triada, a palace site near Phaistos, is an inventory of vases, with the appropriate word for each vase inscribed over each pictograph. Three examples follow:

The first word, , is pronounced *su-pu;* it means a vase of the type shown in the pictograph. The word for the same type of vase is *SP* in Ugaritic, the northwest Semitic language of the Late Bronze Age used at Ugarit, a Syrian port in close contact with Crete by ship.

The second word, , is *ka-ro-pà,* while in Ugaritic it is written *KRP* (plus the suffix *N*); the third word, , is *su-pà-la,* and is

written *SPL* in Ugaritic. Note that in each case the consonants of the Ugaritic correspond to the first letter of each syllable of the Minoan.

All three words designate bowls or vases mentioned in Ugaritic and other Semitic languages. We know that the three Minoan words are vessel-names because the pictographs fix their meaning. Thus, because these Minoan names, like so many other Minoan words, also appear in Ugaritic and other Semitic languages, we can say these languages are related.

Another kind of "virtual bilingual" is the wheat-determinative , accompanying the Minoan word *ku-ni-su:* a Semitic noun designating "emmer wheat." In Linear B the same wheat-determinative accompanies the Mycenaean Greek *si-to,* "wheat." Since Minoan *ku-ni-su* and Mycenaean *si-to* are determined by the same wheat determinative, we have a bilingual correspondence: the Minoan *ku-ni-su,* "wheat" is equivalent to the Mycenaean *si-to,* "wheat" (*sîto-s* in classical Greek).

Totals of listed items are introduced by the Minoan word *ku-lo,* which happens to be the common Semitic *kull,* "all," and introduces totals of listed items in exactly the same way.

Eighteen stone cult objects inscribed with Minoan dedications have been found. While they come from throughout eastern and central Crete, they share enough phraseology to show that they are in the one language used at all the Minoan cultic centers, so that that one language can rightly be called Minoan. Moreover, the dedications employ terminology familiar from well-known northwest Semitic dedications on stone. Minoan *ya-ta-no* means the same as Phoenician *YTN,* "he gave" (as a votive offering); Minoan *pi-te za* means the same as Phoenician *PTḤ Z,* "this engraved stone"; and Minoan *ta-nu-'a-ti* means the same as Phoenician *ṬN'T,* "I set up" (as a votive offering).

In archaic, classical, and Hellenistic times (from the seventh to the third centuries B.C.), the old native language of Minoan Crete continued to be written, along with Greek, in Greek letters. Scholars have been calling that native, non-Greek language "Eteocretan" (genuine Cretan) without knowing its linguistic classification or the meaning of the Eteocretan texts. One Eteocretan-inscribed stone from Psychro (ca. 300 B.C.) perpetuates Minoan dedicatory terminology. It begins *e-pithi z ēthanthē,* "this engraved stone I have given" (= Phoenician-Punic *H-PTḤ Z YTNT[Y]*), giving the 300 B.C. pronunciation of the Minoan words written *pi-te,* "engraved stone"; *za,* "this"; *ya-ta-n(o),* "gave"; and the first person singular suffix *-tī* with the past tense of the verb, a form used over a millennium earlier.

There are also a couple of short Eteocretan-Greek bilinguals, in which the Greek version confirms the northwest Semitic expressions for "to," "mother," "may it be," "they decreed," and some others in the Eteocretan version.

The longest Eteocretan sequence intelligible as northwest Semitic was announced in 1963 when I showed that nine consecutive words were idiomatic for "whosoever he be, fellow citizen or anyone else." This reading was confirmed in 1970 by the appearance of the equivalent expression in a Greek text from the same town, Praisos, and period. Many other Eteocretan readings have been confirmed by the Greek

texts from the same towns, Praisos and Dreros, and times that produced the Eteocretan inscriptions.

That Eteocretan is essentially a continuation of the Minoan, or Linear A, language is indicated by the continuity of basic words, such as "and," "all," "to," and "for." But the most telling evidence is the continuity in the formula for donating engraved stones, as noted above. While the wording of that formula goes with the Canaanite branch of northwest Semitic, there is also some Minoan and much Eteocretan material in the Aramaic branch of northwest Semitic. As might be expected, the northwest Semites of Crete differed dialectally, depending on time and locality. The combination of Aramaic and Hebrew (Canaanite) is common. The Hebrew books of Genesis (31:47) and Jeremiah (10:11) each have a short Aramaic passage, while Daniel and Ezra have long sections in both Aramaic and Hebrew. The same publics often understood both the Canaanite and Aramaic varieties of northwest Semitic.

The Aramaic component of the pre-Greek Cretan population is of interest. Crete was the main center for the transmission of the alphabet from the northwest Semites to the Greeks. On that island, the Minoans and Mycenaean Greeks shared the same syllabic script (Linear A and B) for writing their respective languages during the Late Bronze Age. Later, in such towns as Dreros and Praisos, their descendants continued to write their respective languages, Eteocretan and Greek, in the same alphabet. Some of the names of the Greek letters end in the post-positive Aramaic article *-a*. Instead of the Phoenician letter names *aleph, bet, gimil, dalet,* and others, including *yod, kaph, lamed,* the Greek names end in *-a: alpha, beta, gamma, delta --- iota, kappa, lambda.* The role of the Arameans in the origins of Western civilization is obscured by the fact that the Greeks called all northwest Semitic trading folk "Phoenician," whereas modern scholars have introduced a new terminology with fine distinctions that were of no concern to the Greeks.

The northwest Semitic character of the non-Greek Cretans explains much of the close cultural relationships between the early Greeks and Hebrews, both of whom were intercommunicating east Mediterranean peoples. The awareness of the common background of Hebrew and Greek civilizations is clearing up whole chapters of history. For example, David's technique for training his troops was not understood until the following Greek parallel was brought into the discussion:

Tyrtaeus was invited to Sparta to save that city-state from defeat at the hands of its Messenian neighbors. Like David, he was a musician and poet as well as a general. His poems set to music were used in training troops to function tactically in unison. His elegies exhorted Spartan youth to fight to victory or death, like their heroes of old. David, using the same methods, did for Israel what Tyrtaeus did for Sparta. The key to David's role is found in 2 Samuel 1:17–27, where David's dirge, glorifying the heroic deaths of Saul and Jonathan in battle, aims at training the troops of Judah tactically. Verse 18 tells us that the dirge was composed to "teach the children of Judah the use of the bow." Until the common

This disk, dating from about 1600 B.C., remains undeciphered 60 years after it was excavated at what was the Minoan center at Phaistos. On one side are 30 word groups, on the other 31, possibly reflecting months of 30 and 31 days respectively. At least some of the pictographs are astrological: scales for Libra, fish for Pisces, and so on. The clay disk was stamped between two plates of "type" set with movable dies, so the disk is an early example of printing.

background of Greece and Israel was established, the plain meaning of the phrase was not understood, and many a biblical critic eliminated it from the Bible as a textual corruption.

It is interesting to observe that *Dictys Cretensis,* translated into Latin by Lucius Septimius in the fourth century A.D., preserves the knowledge of the northwest Semitic character of Eteocretan. The ancient introduction to *Dictys* narrates that in the thirteenth year of Nero (A.D. 66) an earthquake exposed some of the contents of Dictys's tomb at Knossos. Some shepherds passing by observed a tin box containing a long document on linden bark, which they gave to their employer. He transmitted the document through the Roman governor of Crete to the Emperor Nero, who had scholarly interests. Nero recognized the "Phoenician" (northwest Semitic) character of the script and language and called in Semitists to translate it into Greek for his library. Three centuries later, Lucius rendered the Greek into Latin.

Dictys Cretensis is written as though it were the autobiography of a Cretan hero who participated in the Trojan War. While it is actually a Hellenistic pseudepigraphon, claiming the authorship of a person who did not in fact compose it, it is not a forgery of the fourth century A.D. by Lucius. This latter false conclusion by nineteenth-century classicists was disproved by the modern discovery of papyri, dated early in the third century A.D., that contain parts of the Greek version. The papyri, from Tebtunis and Oxyrhynchus in Egypt, are more than a century earlier than Lucius's Latin version. Thanks to the decipherment of Eteocretan we can now understand the Phoenician character of the original find, which Nero had translated into Greek. Thus, the modern decipherment of Minoan and Eteocretan would have been regarded as simple translation by the Romans at least as late as the fourth century A.D.

In Hellenistic times there was a rash of pseudepigrapha ascribed to famous men of old. Hellenistic Jewry produced "autobiographies" attributed to biblical heroes, such as the antediluvian Enoch (*The Book of Enoch*) and the twelve sons of Jacob (*Testaments of the Patriarchs*). The northwest Semitic pagans on Crete were subject to the same literary trend, but they took their themes from Homer.

The Minoan inscriptions are largely cultic. Not only are the dedicated stone objects of a religious nature, but also many of the lists of commodities on clay tablets are offerings to the gods. The personal and divine names reflect the mixed composition of the population and the origin of the cult.

The Minoan population was mixed. Two names in the Minoan inscriptions are Hurrian: *Da-ku-se-ne* and *Su-ki-ri-te-se-ya.* The Hurrians, whose kingdom was in northwest Mesopotamia, were an important segment of the population throughout the Near East during the second millennium B.C. Now we are finding out just how influential they were on Crete.

More numerous are the Egyptian names reflecting the cult of the sun god Re: *Ne-tu-ri-Re* ("Re is divine"), *A-ra-na-Re* ("Great is the name of Re"), *Pa-ya-Re* ("He of Re"), *Ya-mi-da-Re* ("He who is from the hand of Re"), and more than twenty other Re names. The influence of the Re cult in the Aegean was pre-Minoan, for on the island of Cythera an Egyptian inscription, reading *Sep-Re* (the name of the Sun Temple of Userkaf, the first Pharaoh of the Fifth Dynasty), harks back to the mid-third millennium B.C., long before the first Minoan palaces. The impact of the Re cult on the delta Semites is also reflected in Hebrew Re names (*Reuel,* "Re is God," and *Ahira,* "Re is fraternal") and in the tradi-

A typical Minoan fertility goddess figurine. She wears a flounced skirt, has bare breasts, and holds snakes in her half-raised hands. This glazed clay idol from the early sixteenth century B.C. was excavated in the palace of Knossos.

tion that Joseph married Asenath, the daughter of the priest of On, where Re was worshiped.

Many of the identifiable names are familiar from northwest Semitic literatures. *Da-we-da,* which occurs four times in the Hagia Triada tablets, is "David." A name written varyingly as *Ki-ri-tá, Ki-re-tá,* and *Ki-re-ta-na* is probably the deified hero of Crete who gave the island its name. He appears in Ugaritic literature as *KRT* (and once as *KRTN*), the name of a deified king whose parents are El and Asherah, the chief god and goddess of the Canaanite pantheon. The contacts between Ugarit and Crete are many-sided, including mutual seaborne trade, as spelled out in a legal document from Ugarit. The Minoan *Ti-ni-ta* is the popular Phoenician-Punic goddess "Tinit" (often misspelled "Tanit" in modern books). But in spite of the many figurines of the goddess with bare breasts, flounced skirt, and half-raised arms (often holding snakes), most of the deities that receive offerings in the texts are male. The commonest are *Gu-pà-nu* and *'A-du,* who are given offerings in the Hagia Triada tablets nine and seven times, respectively. *Gu-pà-nu* ("vineyard god") and *'A-du* are both in the Ugaritic pantheon. *'A-du* (pronounced 'Addu or Haddu) is an alternative name of Baal, the most active god in the Ugaritic pantheon.

The predominance of male gods in the texts, in contrast to the frequency of the goddess figurines, confronts us with a contradiction that is more apparent than real. Before the decipherment of Minoan, the figurines had created the impression that the cult was female oriented. It is instructive to compare this with the situation in Palestine, where the biblical text makes it clear that the official God is male but that He was not to be worshiped as a graven image. Palestinian archeologists have found no graven images of Yahweh, but many figurines of Astarte, the goddess of the popular fertility cult. There is no real contradiction between the Minoan texts and idols. The official cult was male oriented but not idolatrous. The popular, but unofficial, fertility cult did, however, find expression in goddess figurines. The aversion to idols is oddly enough anticipated in early

Egypt, where there are hardly any sculptured images of gods before the Twelfth Dynasty. The Re cult particularly shunned any three-dimensional image of Re in the solar temples.

The most interesting archeological confirmation of the northwest Semitic character of the Minoans was detected in the mid-1960s by George Bass of the University of Pennsylvania, who excavated a Late Minoan shipwreck of the thirteenth century B.C. at Cape Gelidonya off the coast of Turkey. The cargo, including hide-shaped copper ingots was Aegean. The vessel, however, was made of Syrian timber, and the captain's seal is Syrian. Thus, the ship and its management are associated with the northwest Semitic sphere, although they were shipping Minoan wares in the Aegean home waters of the Minoans. In addition to uncovering the evidence, Bass interpreted it to show that the decipherment of Minoan is supported by material evidence of northwest Semitic hegemony in the Aegean during Minoan times.

Throughout the millennia earthquakes have wreaked havoc on Crete and may have contributed to the destruction of the "old palaces" of Middle Minoan II (1850–1700 B.C.) and of the "new palaces" in Late Minoan II (1450–1400 B.C.). Recently, much attention has been drawn to the volcanic eruptions of Thera, a small Aegean island with an active volcano that in Late Minoan times erupted with baleful effects. On Crete the tephra blown from Thera was deposited so heavily that it convulsed Minoan civilization and for a long time rendered agriculture impossible. On Thera itself the buildings were buried and preserved by the volcanic deposits, but not so suddenly as to prevent people from escaping with their most valued possessions. But at Kato Zakro, at the east end of Crete, considerable treasure was found, suggesting a more sudden disaster. When did the severest of the eruptions take place? Higher estimates put it at about 1500 B.C.; the lowest, at about 1200 B.C., when the Late Bronze Age gave way to the First Early Iron Age (1200–900 B.C.). Such matters may eventually be solved by a more conclusive sampling of carbon-14 datings of organic remains buried within the tephra deposits. Meanwhile, this much may be said for the late (1200 B.C.) date: that time marked the maximum dislocation and movement of peoples in the east Mediterranean. The sea peoples, including the post-Minoan Philistines from Crete, were on the move. After being repulsed by Ramses III from Egypt in about 1185 B.C., they occupied the Philistian Plain, which (together with all Palestine) is named after them. The names of the Philistines and their gods (for example, Abimelech and Dagon) are, more often than not, Semitic, and since they are represented as never having a communications problem with the Hebrews, they apparently came to Palestine speaking a northwest Semitic dialect of their Minoan homeland.

It was also in about 1200 B.C. that a whole network of Aramean states sprang up suddenly in Syria, from Damascus northward to the Syro-Hittite city-states at Homs, Hamath, and Aleppo, among others. Where did all those Arameans come from? The Aramaic features in Minoan and Eteocretan suggest that many may have emerged from the Aegean in the wake of upheavals, natural and human, that took place about 1200 B.C. The Arameans' skill in commerce and international relations favors Minoan connections.

The opening up of the Minoan inscriptions is the key to the identity and character of the first high and literate civilization on European soil. The decline of Minoan power was connected with the rise of the Greeks in the heroic age depicted by Homer, and with the upheaval throughout the Near East, as the Late Bronze Age gave way to the First Early Iron Age. The prophet Amos understood that the dislocation of peoples was not limited to one nation but was rather the concatenated destiny of many nations. Accordingly, he has God bringing not only Israel out of Egypt, but also Philistines from Caphtor (Crete) and Syrians (Arameans) from Kir (Amos 9:7).

The Minoan legacy supplied the impetus for much of Greek and Hebrew civilizations. The Mycenaean Greeks carried on Minoan culture, while Hebrew nationhood was largely Israel's response to the rule of the Philistines from Crete. ■

The Secret Life of Beatrix Potter

Continued from page 41

similar organisms. By 1894, Beatrix Potter was sufficiently advanced in her own researches to take a lively interest in Johannes Reinke's findings in that year that symbiosis was the life force responsible for generating a new departure in plant life: the lichen.

But she could find no one at either the Kensington Museum or at the Royal Botanic Gardens at Kew who would concur with her own microscopic findings about the processes integrating fungi and algae into lichens. It took a great deal of tactful talking on her part to bring the assistant at the Royal Herbarium halfway around to "believe my new-thing, Lichens," she wrote in her journal, pinpointing by a date, November 27, 1896, when her "idea of the lichens" first came to her. Her observations of symbiosis convinced her that the fungal partner was not a parasite, but a contributing member of a pair Reinke called "two consorts."

To prove this theory to the authorities at Kew, Potter drew on the know-how of her uncle, Sir Henry E. Roscoe, a chemist who had been knighted two years earlier for his scientific contributions. He suggested ways of testing the algae for chlorophyll lines with a spectroscope.

This research led Potter to the conclusion that, far from the parasite that some German and Swiss botanists held the fungal partner to be (authorities in England doubted it was a partner in any sense), the fungus contributed minerals extracted from air and water needed by the alga. Alone, the fungus had no chlorophyll for making its own food. The alga had green chlorophyll, which traps light, converting it to chemical energy for turning carbon dioxide into sugar. While the alga manufactured the sugar, starch, and oxygen that nourished itself and the fungal strands, what triggered the chlorophyll to act was water stored in the sponge-like fungus. The alga had a modicum of water, but it was excited to vigorous photosynthetic activity by contact with the fungus, whose rapid uptake of liquid water was by imbibation. After a rain, some fungal components hold up to 35 times their dry weight in water. They have the capacity to absorb water from fog, dew, and the air. The photosynthetic activity of the algal component is stimulated by the fungal partner's surplus water, which contains dissolved mineral salts, chemicals, and carbon dioxide—all elements needed by the alga to make vitamins for both.

It was through her uncle, Sir Henry, that Beatrix Potter finally got the opportunity to meet the director of the Royal Botanic Gardens, Sir William Turner Thiselton-Dyer. Sir Henry, while paying a sick call on her father, looked at her portfolio of fungus paintings and impressed, offered to take her to see Thiselton-Dyer.

Once at the Gardens, she noted with astonishment that her uncle, in introducing her to five different officials in turn, had assumed an engaging simper. The assistant director, D. Morris, was sorting crumpled papers containing gums from Arabia. "I know nothing about fungi," he told them brusquely. "I am exclusively tropical."

They left him to his specialty and went across Kew Green to the herbarium, pausing to see W.B. Hemsley, but he was too intent on stacks of dried papers to give them any time. One assistant, George Massee, did look at her drawings with pleasure. But J.G. Baker, the librarian, a thin man who seemed himself to have "been dried . . . under a press," took refuge in the silence of a deep bow.

At last they were in the office of Thiselton-Dyer. With a cigarette in one hand and an alert manner, he turned the pages of her portfolio. A look of surprise came into his face. "I'll be glad to renew your student ticket to admit you to the gardens and the library," he told her, and then, turning to her uncle to talk about politics, he did not address her again. She had built herself up to meet each in turn and now she was tired. She felt that Thiselton-Dyer thought she was too young to be given further consideration.

She had brought her drawings to the director to show him that while the fungal strands enclosed the green algal cells securely to draw in carbohydrates, vitamins, and oxy-

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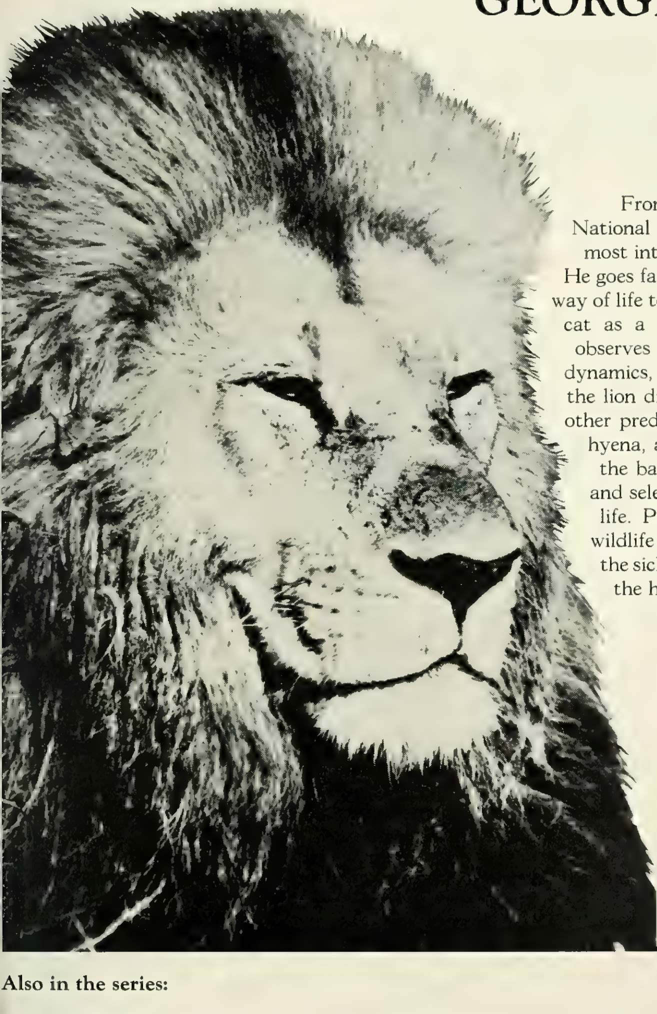

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gen, the water from swollen fungal hyphae was crucial for this process and yielded mineral nutrients to the alga partner. The fast-growing hyphae cling to bare rocks, extracting ions and minerals, anchoring the algae while the fungal walls shield the algae from too intense light. She pointed out that the antibiotic qualities of the substances adhering to the fungal strands protect lichens from pathogenic attacks, insuring a greater longevity to the composite plant than either component could enjoy alone. But Thiselton-Dyer was indifferent, and shrugged away her paintings as too artistic to meet scientific criteria.

Three weeks later she went back to Kew and sought out George Massee, the assistant who had seemed interested in her paintings. He showed her the fungi he was growing under glass covers, and as he talked she detected that his ideas were "not founded on very sufficient evidence." It was clear to her that the man had "passed several stages of development into a fungus himself."

From there, she went to the Museum of Natural History to identify some specimens and "was further edified by the slowness of the officials." It wasn't that they weren't kind. What bothered her was that "they do not seem to be half-sharp." B. Waterhouse, in charge of beetles (one of her subjects in painting), looked so much like a frog that she had once kept as a pet that she couldn't bring herself to discuss beetles with him. Sir William Flower passed her and remarked pleasantly on her bonnet. What is his subject besides ladies' bonnets? she wondered later in her journal. Her day was saved by meeting a Mr. R. Pocock, who liked her painting of a male crab spider and talked about spiders with her. She didn't tell him she thought the spider case was "an extreme example of museum labelling run mad." In her journal that night she wrote, grimly, "They are almost too much specialists; they really seem less well informed than an ordinary person on any subject outside their own."

She continued to develop theories about fungi. Those that spring up on fresh manure in the summer, she decided, must have another source to take them over the winter

GARUDA is a part-bird, part-human deity who is worshiped by Hindus and Buddhists, as well as by the followers of Bon, the pre-Buddhist religion of Tibet.

months. She concluded that all higher fungi must have a mold. This is how, she reasoned, the *Chlorosplenium* gets from log to log "without cups to spore." Her uncle advised her to write a "fishing" letter to Massee at Kew ostensibly asking for a book, but actually trying to find out how much the authorities knew about spore culture.

The answer came two days later on a postcard: "*Botanische Untersuchungen über Schimmelpilze,* by Oskar Brefeld." Disgusted, the next day she drove to Kew in her pony cart and faced Massee with a direct question, Had Dr. Brefeld actually "got the mushroom mould"? Massee said, "No." He was looking at her vaguely through his glasses. It took her only two minutes to discover that Massee "knew very little about it." The discussion about her mushroom slips became heated. She wrote in recollection of the encounter: "I am afraid I contradicted him badly."

Her uncle exulted, "No one but you and Dr. Brefeld have grown spores." Sir Henry urged her to write a paper on her theory. When she showed her father the first draft of her paper, he dismayed her by going through it with a proprietary pencil. After listening to his remarks about her grammar, she wished she had never shown it to him.

Her ideas about lichens generated "another idea about hybrids." She looked forward to delivering the paper to Thiselton-Dyer and to discussing it with him. She went so far as to take the train to Kew, but when she reached the gates, shyness overcame her. She watched through the window for fifteen minutes before going in; then she sat in an outer room and tried to distract herself by feeling the patterns on the chair legs. When an old gentleman came to the door to look at her with curiosity, she "incontinently fled."

The following Monday, she returned to Kew. Although it was a long wait, this time she stayed until an impatient and cynical Thiselton-Dyer bounced in, telling her that her opinions were mares' nests, that he hadn't time to look at her drawings, and that she ought to go to Cambridge University. "It will all be in the books in ten years," she told him. She left at that point, be-

cause she found herself beginning to laugh.

In the herbarium, she found that Massee had become a convert to her theory. But in listening to him, she had to conclude that he didn't have a very clear concept of it. She found herself amazed at "how botanists have niggled at a few isolated species and not in the least seen the broad bearings of it." As it was, Massee urged caution and continued experiments.

A week later she stopped by to visit her uncle. He had finished his breakfast and was sitting back on the sofa, smoking. He told her he had received a "rude and stupid" letter from Thiselton-Dyer.

"Maybe there's more to what you are working on than even I realized. Do you think you could explain to me in detail and very carefully just what it is you are advancing?"

She was delighted. Pulling paper and pencil toward her, she drew and sketched while she explained. Sir Henry listened intently, making a great effort to understand, asking at each step, "Are you quite sure?" Annoyed at the slight given to one under his patronage, he told her that no stone would go unturned until her paper went to the most prestigious scientific group in London, the Linnean Society.

Thiselton-Dyer's rude letter acted on him as a spur. Sir Henry's single-minded absorption in showing up the martinet in charge of the Royal Botanic Gardens made him forget a touch of gout, and he soon sent for Beatrix again and questioned her closely. He pointed out places in her paper that she had to clarify.

"You've seen," he asked her, "that most fungi can form a product that looks like yeast?"

"Yes. And since telling you that, I've found Brefeld agrees."

"Does Brefeld have it all?" he asked searchingly.

"He has plenty of facts and plenty of experiments, but he doesn't know which are of interest and which are deadwood. He has theories, too; but they don't piece on to the experiments."

"And Pasteur?"

"He stopped experimenting after he tried and failed to get yeast from *Penicillium*, but he took it for a single species, whereas there are hundreds."

That night, stimulated by her discussion with her uncle, she worked on her paper until midnight, even though it was Christmas. To have spent the whole afternoon discussing lichens with her tireless, white-haired uncle and the whole evening writing about them was to Beatrix Potter, the lichenologist, the perfect way to spend her thirtieth Christmas. The next morning she was up bright and early, paper in hand, going across the snow to her uncle's. She thought it would take but a minute for him to look over her paper, but he had gotten his second wind. With a well-sharpened pencil, he pointed out places in her paper where more references "and putting together" were needed. As the morning wore on, she realized that she had more writing to do before braving "the misogynist."

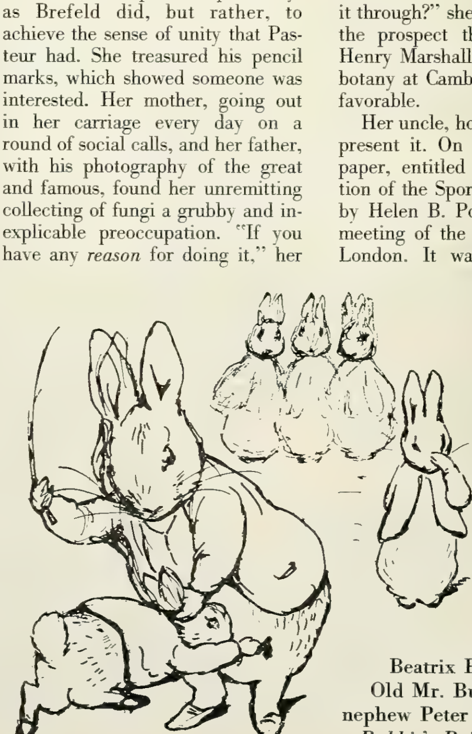
Her uncle said, "It's because you're an outsider that you have to get this right," and lent her some more of Pasteur's works.

Once home, she saw what he was trying to do for her. He didn't want her to throw in pieces haphazardly, as Brefeld did, but rather, to achieve the sense of unity that Pasteur had. She treasured his pencil marks, which showed someone was interested. Her mother, going out in her carriage every day on a round of social calls, and her father, with his photography of the great and famous, found her unremitting collecting of fungi a grubby and inexplicable preoccupation. "If you have any *reason* for doing it," her mother told her, "I don't want to hear it."

Beatrix Potter was beginning to have serious second thoughts about pitting her amateur know-how against the big guns at the university and the London Linnean Society. In retrospect, her long years of sharing data with herbalists met on the road or with Charlie Macintosh, the postman, seemed better. When he had called at her invitation five years before, Macintosh told her he was studying freshwater algae. At the time, she wrote that as he looked over her drawings, his accuracy in "minute botanical points gave me infinitely more pleasure than that of critics who assume more, and know less." Now, five years later as she prepared to go to London to face the experts, she wrote in her journal, "I prefer the sagacity of the man in the street."

Coming to her uncle's with the final draft of her paper on the last day of January, she was in a "state of abject fright." He read the paper intently, suggesting no further changes. "Do you think Professor Ward will have the patience to read it through?" she asked, facing up to the prospect that the opinion of Henry Marshall Ward, professor of botany at Cambridge, might be unfavorable.

Her uncle, however, urged her to present it. On April 1, 1897, the paper, entitled "On the Germination of the Spores of *Agaricineae,*" by Helen B. Potter, was read at a meeting of the Linnean Society of London. It was read by George



Beatrix Potter's drawing of Old Mr. Bunny whipping his nephew Peter was used in *Peter Rabbit's Painting Book,* 1911.

Massee; Beatrix was not present, for only men were allowed to attend the meetings.

The paper told of her experiments in trying to get spores to propagate apart from their natural habitat. Before the paper could be published, however, she withdrew it because she wanted to conduct further experiments. Her extensive reading, as well as her talks with authorities at the museum and herbarium, made her aware that she was the first Britisher to break ground in the germination of spores, and the first Britisher to point out the positive contribution of fungi to algae in the lichen union. She wrote in her journal regarding chlorophyll and symbiosis, "I don't think anyone else is *at it.*"

It helps one to understand how hotly that lichen controversy raged by realizing that even today the question is unresolved. While most authorities unquestioningly affirm the reciprocal benefits enjoyed, in some degree, by the two components making up the lichen, others assert that, in most cases, the relationship is parasitic. A few claim that there is no transforming exchange in lichens, since the alga can exist independently if separated. The controversy persists, largely because of the many types of lichenized unions. Most authorities agree that lichenology has more unexplored horizons than any other field of plant study.

Now that her theory had reached British scholars, Beatrix Potter hoped that if any of those botanists present at the meeting mentioned it in their books, they would acknowledge her. But the prospect of devoting another two decades of her life to achieve a second footnote in the botany books was no longer inviting to her. However, what prevented Beatrix Potter's receiving even delayed appreciation for her studies was that at her death in 1943, or shortly thereafter, many of her voluminous notes were burned. Among these was her paper on spores.

She gave up her studies of spores two years after she had asked for the return of her paper because the time and energy she had invested in painting fungi and lichens now went into writing and illustrating children's books. She found the response from child readers much more heartening.

The children in her former governess's family had always delighted in the illustrated letters she wrote to them. When in 1890, seven years before her lichen paper was finished, she received her first check for six Christmas card designs, she was so pleased she gave her rabbit model, Benjamin Bouncer, a cupful of hemp seeds as a reward. When she tried to use him as a model the next morning, she found him partially intoxicated and unmanageable.

Beatrix began to wonder if a whole book about a rabbit would be equally well received, and she sent her book to six publishers, to no avail. The individualist who had gone past an impasse at the museum to reach a scientific audience at the Linnean Society, in a similar way went past the rejection of publishers by paying a printer named Strangeways to print her first book for children. When it appeared, the firm of Frederick Warne, Ltd., informed her that they would issue it under their imprint if she would redo the pictures, this time using color. So with the same preciseness she had used to differentiate fungi, she now set herself to learning and perfecting the technique of creating color illustrations for small books.

The Tale of Peter Rabbit has been on the list of best-selling children's books every year since its appearance seventy years ago. It ushered in a new career for its author. She put aside the detailed watercolors of fungi (by 1901 she had completed 270—all of which are now in the Armitt Library, Ambleside, England), intending to return to her research and drawings of spore development after the interest in Peter Rabbit died down. But the clamor of children and of booksellers led her to invest her energy in producing book after book, twenty-five in all. The spore paper was never published, nagging her with the sense of a goal not attained.

One easily detects this flavor of frustration in Beatrix Potter's storybooks: the sense of being kept from a desired goal. The tailor of Gloucester can't work on the wedding garment because the cat has stolen the twist of thread he needs for his buttonhole. Jeremy Fisher, the frog, can't treat his friends, the tortoise and salamander, to a min-

now dinner because he has been swallowed by a trout. Peter Rabbit can't range the garden at will because of the upraised rake of the pursuing gardener, McGregor. Squirrel Nutkin, with Beatrix-Potter-like effrontery, dared to twit the owl—who represented the Establishment on the island—and lost his tail. Tom Kitten was stopped in his exploring by two rats, who tied him up and wrapped him in dough to make a pudding of him. Jemima Puddle-duck found a "safe" place to sit on her eggs as guest of a suave fox who, like Sir William Flower with Beatrix Potter, complimented Jemima on her bonnet.

As the royalties from her books increased, Beatrix was able to buy a farm at Sawrey. In 1913, at the age of forty-seven, she married William Heelis, a solicitor who advised her in buying land in the Lake District. With him she enjoyed thirty years of happiness. Little is known of these years, however, for she had ceased writing in her journal on the day in 1897 when she brought the final draft of her paper on spores to her uncle.

After her marriage she became a sheep raiser, with a summer population of 1,800 Herdwick sheep and 70 head of cattle on her ten farms. Many of these she brought to fairs in the autumn, where other breeders sought her advice. So skilled was she in raising the hardy blue sheep that the farmers of Sawrey elected her president of the Herdwick Breeders' Association, the first time a woman had ever held that post. Into one of her longest books, *The Fairy Caravan*, she put her experiences of rescuing sheep who had gotten cragged or buried under snowdrifts, flavoring the book with shepherds' talk.

In her seventies, when she was too old to climb the steep mountain crags, she walked the windswept hills in her mind's eye, knowing by heart every path, boulder, overhang, and stream. So that none of this countryside would be urbanized, she used her book royalties to buy farm after farm, willing 4,049 acres and fifteen cottages to the National Trust as a place of sanctuary where no hunter would rout the sheep and birds or chase Peter Rabbit. In peace then, in 1943 at the age of seventy-seven, she could close her eyes upon it all. ■

by Raymond F. Dasmann

The Aftermath of Stockholm

Will the seeming promise of last spring in Sweden endure the coming winter in New York?

ONLY ONE EARTH, by Barbara Ward and René Dubos. *W. W. Norton & Co., Inc., $6.00; 225 pp.*

The first United Nations Conference on the Human Environment came to its predicted conclusion on June 16, 1972, in Stockholm. The results were clearly those that were expected. In view of more than three years of preparatory work, it was most unlikely that Stockholm would produce any real surprises, and it is to the credit of the conference secretariat that it did not fall far short of the mark.

Outside the conference halls, the world continued on its collision course with ecological reality. The weary delegates flew home. They flew across the poisoned Baltic and the oil-stained North Sea, over the filthy Rhine to the polluted shores of Lake Geneva. They passed far above the ever widening margin of the Sahara, where dust clouds rise from once productive grasslands, and on over empty African plains where game herds once darkened the ground. Sealed off from the roar of bulldozers and the whine of chainsaws crunching their way into the last great refuge of neotropical life, they flew above the erstwhile wilderness of Amazonia. Some returned to the hopelessness of Calcutta, others to breathe the toxic air of Tokyo, a few to the hatred and despair of Indochina. All returned to the real world to console themselves with dreams of development and progress.

Those who had come to Stockholm full of hope and optimism, and there were a few, left with their spirits perturbed. Those more familiar with the realities of intergovernmental life were pleased with the results. Ideally, of course, the conference could have been a gathering of well-informed people, brought together to seek truth and find answers to the environmental dilemmas that confront mankind. Realistically, it could not be, and truth was not welcomed on the conference floor. Within the rules that thus far govern all gatherings of nations, it was a conference of politicians. Perhaps some had a deep concern for man and his environment, but all were bound to see that their nations lost not one iota of sovereignty, and gained every possible political advantage.

To prepare the world for the realities of Stockholm, the Secretary-General of the United Nations Conference on the Human Environment, Maurice F. Strong, commissioned an unofficial report—a book—to be written by development-economist Barbara Ward and microbiologist-pathologist René Dubos. To help them in their labor, the assistance of a 152-member

Three Japanese victims of mercury poisoning walk from a plane at Arlandia Airport to attend the Stockholm environmental conference.

committee of corresponding consultants in 58 countries was provided. Despite this formidable handicap, these highly talented writers have produced a well-written, and in places, a beautifully written book. Any author knows that this is no mean achievement. In the words of Maurice Strong's preface:

"The names of Barbara Ward and René Dubos are listed quite properly as authors of the report. They are indeed responsible for the drafting and revision of the manuscript to which they both contributed at personal sacrifice, under remorseless time pressure, with unstinting assistance of a very small staff, and without compensation. They are responsible, too, for its general style. It would be quite impossible to describe adequately the spirit and energy that they invested in its enterprise."

Perhaps because of the unwieldy apparatus established for its production, and despite the spirit and efforts of the authors, the book was published too late to help at the Stockholm conference. If the public had read it beforehand, if even the delegates had read it beforehand, or more importantly, if those responsible for appointing the delegates had read it, some greater realization of environmental realities would have been apparent at Stockholm.

Many days into the deliberations at the conference, one bewildered delegate spoke from the floor: "It would help if we could be told just what is meant by the word environment." Indeed, it might have. In this book, the conference secretariat's viewpoint on the subject, as shaped and conditioned by the attitudes of governments, is expressed. One can learn much from its emphases and its omissions.

In part one, "The Planet's Unity," we encounter some little ecology, a bit more of natural science in general, and a large lacing of economics. The emphasis is historical and focuses on man. While it is apparent that mankind inherited a world of nature, there is no pause to study its rules or contemplate its magnificence. Part two, "The Unities of Science," moves from physics, with its view on matter and energy, through evolutionary biology to a further brief consideration of ecology. In part three, "The Problems of High Technology," we reach what is to be one major theme of the book and of the conference: the question of pollution and its relation to economic development. In this section the facts concerning the pollution of air and water are briefly but adequately covered. We are warned of the dangers of persisting in our present ways and shown some ways out of our pollution problems. Nevertheless, the viewpoint is economic and we are warned of the costs of insisting that things be too clean. In preparation for Stockholm we are not led to ask for too much.

The chapter on "Man's Use and Abuse of the Land" is less about the land than about solid-waste pollution and the problems of urban settlements. The latter represents a second major theme of the book and the conference. There are two pages, well-enough written, on wilderness, and a bit on national parks.

We move next to "The Balance of Resources," and here the viewpoint of the development economist takes over. Once more we are told that each child born in America contrives to consume, by the time he is grown, an incredible amount of energy and raw materials, and that all Americans collectively will "create over 30 percent of the world's drain on nonrenewable resources." European nations, Japan, and other technologically advanced countries come in for their share of the blame. These are words that stir up the delegates from developing countries, who see themselves being left farther and farther behind in the rush for consumption. Yet the other side of the coin is not clearly examined. What would happen if the consuming countries were to suddenly cease consuming so avidly, if the markets for oil, minerals, and agricultural produce were to suddenly dry up? Could the poor countries grow rich by selling each other petroleum and palm oil? The problem of maldistribution of the world's wealth is real and cries out for solution. But the answers will not be simple and are less likely to be sought if invective and abuse are heaped on the haves by the have-nots.

In part four, "The Developing Regions," a further major theme of the conference emerges—the rela-

The menu that dates back 500 years before Marco Polo.
There are certain scholars who claim the Orient taught Europe how to cook. Perhaps the answer makes little difference. After all, the name of a famous Japanese dish, tempura, is actually a bit of Latin passed on to us by a Portuguese sailor long ago.
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tion between development and environment. In this section the problems of the developing world are well presented: the poverty and hunger, the desperate attempts to raise living standards and the environmental backlash that sometimes follows, the pressure of population, the green revolution, the changes in rural lands, and the worsening conditions of urban life. The need for environmental considerations in the planning of development becomes apparent, but the likelihood that they will be given the necessary attention seems remote.

Relatively little attention is given in the book to the diversity and complexity of the natural world and its significance to man's welfare. The role played by the natural wealth of living creatures in maintaining the health and functioning of the biosphere, in keeping it fit for human occupancy, while not ignored, is scarcely emphasized. One can understand how the delegates to Stockholm persist in their illusion of an unlimited earth, rejecting the concept of limits to growth. But an ecologist can only wonder how such an illusion persists, just as an astronaut might be baffled by meeting a believer in a flat earth. Not strangely, however, the Stockholm conference paid more than lip service to the need for protection of wildlife and natural communities, and a surprising degree of enthusiasm and unanimity was displayed in calling for a ten-year moratorium on whaling. Virtually all resolutions on national parks, genetic resources, and protection of wild species passed with little debate. One wonders why those who prepared the conference did not ask for more. Such subjects, for the moment at least, are politically neutral.

In reading Barbara Ward and René Dubos's book, one finally realizes a depressing significance to the title *Only One Earth.* Alternatives to development in the traditional sense are scarcely considered. The prospects for maintaining a diversity of life-styles suited to the great genetic diversity of the human race are mostly passed over. The rights of those who were not represented by governments at Stockholm—the different peoples and cultures that do not hold political power and who may not seek to

participate in an urbanized world of high technology, but rather to find different paths to happiness—are certainly not examined. Instead, economic development in its traditional Western sense is considered to be essential for the United Nations family. All men must be caught in the technological net and drawn closer and closer together.

It would be easy to feel bitter about the bad behavior of governments at Stockholm. It is difficult to sit and watch nations behave like compulsive gamblers at a roulette table, prepared to risk the future of mankind for a bigger share of the earth's riches now. Yet such bitterness would be based on an unwarranted optimism about the capacity of man to see beyond his immediate problems to an altruistic concern for tomorrow. The Stockholm conference did what it was asked to do. We have a declaration on the human environment, a bit muddled by anti-neocolonialist, anti-imperialist statements, but one we would do well to respect. We have prospects for a new United Nations Secretariat that can do something about environmental problems, and for an environmental fund with which it can work. The conference produced an action program for the United Nations with some excellent recommendations for international action, which governments and international agencies must consider. We will have an "earthwatch" to monitor and measure the growing sickness of the planet, and perhaps not too late, to have its warnings respected.

The Stockholm conference, of course, only recommends to the United Nations General Assembly. In New York in December, the Soviet Union and its friends will be in full attendance, anxious to make up for the opportunities lost through their absence at Stockholm. The Chinese will be there, confirmed in their belief that a strong dose of Chairman Mao's revolutionary medicine can cure the problems of population and environment. The Third World will again be on the attack, guarding its right to pollute and to do whatever it desires to the environment within its borders.

It is still likely, however, that most of the good that came out of Stockholm will survive New York. Perhaps the best preparation that

the average citizen can make for the General Assembly is to carefully examine the contents of *Only One Earth.* Perhaps there will be time to communicate his concern to his national delegation.

Raymond F. Dasmann is senior ecologist at the International Union for the Conservation of Nature, Switzerland.

THE ORGANIC GARDENER, by Catherine Osgood Foster. *Alfred A. Knopf, $7.95 ($2.95 paper); 234 pp., illus.*

Traditionally, the topics of conversation that engender heat without light have been politics and religion, but we can now add organic gardening to the list. The true believers and the nonbelievers—manureheads vs. nozzleheads—can be really poor dinner companions, and frequently they are bad gardeners and/or poor scientists, as well. A debate between a Rodale and a Borlag would not only be uninteresting, it would also be distasteful. Thus, even though I am a professional plant physiologist and supposedly antiorganic, I want to start this review by saying that *The Organic Gardener* is really a pretty good book and should be read by anyone who is thinking of using the so-called organic method.

Soil is basically pulverized rock plus variable qualities and quantities of complex organic materials in which a marvelous assortment of organisms live. Although plants will grow beautifully in inorganic mineral solutions, plants in soil have to be in intimate root-soil contact with water containing dissolved, required minerals in the correct proportions and quantities. Raw mineral rock cannot properly hold and supply this soil solution, it cannot provide the environment for proper root development, and it usually cannot maintain the acidity-alkalinity balance that the root system must have to allow optimum water and mineral uptake by plants. The organic continuum, usually called humus, that facilitates these processes is continually being broken down by leaching, by the action of soil organisms, and by other processes; and as it disappears, soil compacts, roots may become oxygen deficient and dry out, and the

whole plant suffers. It is, therefore, prudent and thrifty gardening practice to encourage and assist in maintaining adequate organic humus in soil. This is just about 90 percent of the organic gardening story and is above reproach.

Another 5 percent of the story is the desire to eliminate pesticides and other plant protective agents. Companionate planting—the ancient technique of introducing plants that repel insects—and rigorous, diligent, and individual attention will control many insect pests. Picking bugs off one by one or washing each leaf with a soap solution can be done only when the garden is small and leisure time available; a fifty-acre tomato field is quite another matter. Bacterial and fungus pests can, in some instances, be controlled nicely by cutting off infected leaves, pulling out "sick" plants, and especially by thrifty garden practice. There is, however, little evidence for the author's assertion that only poor plants become diseased. What she is probably seeing is effect and not cause.

The last 5 percent of the story involves fertilization. That organic additives can supply the inorganic minerals required by plants is unquestioned. But serious questions can be raised regarding the statements that vitamins and other biologically important molecules can be supplied to intact plants through the root system. Indeed, intact plants are rarely deficient in such substances. The main bone of contention is whether the plant can distinguish between, say, a phosphate ion derived from compost and the ion supplied from a bag of commercial fertilizer such as 5-10-5. Leaving aside the mystical cult of Nature worship, I contend that there is no difference. If we accept the concepts of controlled experimentation, all the available evidence supports my point of view. Be it noted, however, that adequate humus provides the soil structure that permits root aeration, adequate moisture, a balanced soil solution, and other conditions that facilitate the absorption of that phosphate ion.

It is a general biological principle that the efficiency with which nutrients are used by organisms is about 10 percent. The relevance of this to all recycling should be borne

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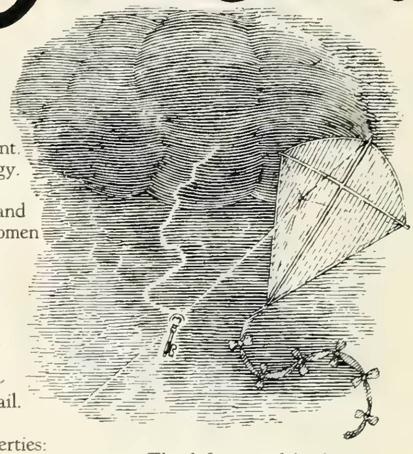

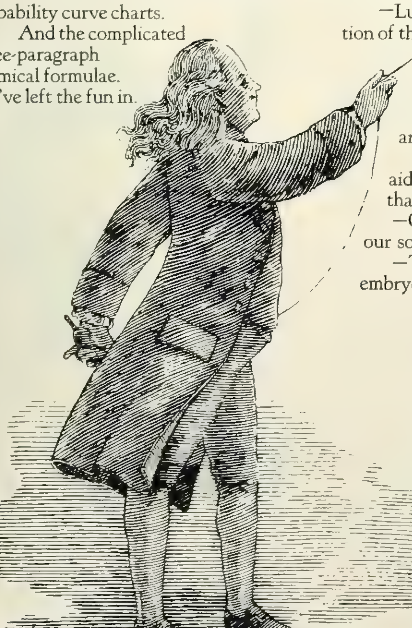

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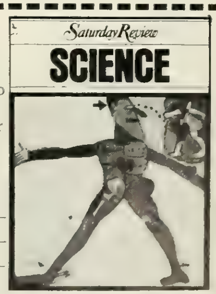

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in mind. Of the initial mineral level in materials to be composted, only about 10 percent is available to the plant supplied with the compost, and the plant can use about 10 percent of this for its development. The same order of magnitude changes occur at each turn of the cycle. This does not mean that recycling should not be mandated; our wasting of potentially useful sewage and other compostable material is sinful. It does mean that even if all of the potential humus in the world was efficiently recycled, we would still have need for input of industrially prepared fertilizers. With the need to grow plants to feed the results of enthusiastic human overbreeding, the fertilizer industry is vital in world economies. Any other evaluation of the recycling problem is wishing for a perpetual motion machine.

As I said, this is a pretty good book. The text has many useful recommendations, there is a wealth of information on the how-to of companionate planting and the construction of compost heaps, plus a few intriguing recipes. The plant physiological explanations are a bit simplistic and occasionally in conflict with present knowledge. Some of the home brew formulas for organic sprays are probably worth the time to test. Most important, one gets the impression of a warm and intelligent person talking to you—a delightful style of writing that is seldom presented in expository prose courses. The illustrations, however, aren't worth the paper or ink.

RICHARD M. KLEIN
University of Vermont

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Suggested Additional Reading

STONE AGE REVISITED

NATIVE PEOPLES OF SOUTH AMERICA. J.H. Steward and L.C. Faron. McGraw-Hill Book Company, New York, 1959.

INDIANS OF BRAZIL IN THE TWENTIETH CENTURY. J.H. Hopper, ed. Institute for Cross-Cultural Research, Washington, 1967.

ONE SMALL STEP FOR SCIENCE, ONE GOOD MEAL FOR THE SHIP'S CAT

A HISTORY OF POLAR EXPLORATION. L.P. Kirwan. W.W. Norton and Company, Inc., New York, 1960.

ZOOLOGY OF HMS *Erebus* AND *Terror* UNDER CAPT. SIR JAMES CLARK ROSS, R.N., F.R.S., DURING THE YEARS 1839-1843. J. Richardson and J.E. Gray. E.W. Janson, London.

THE SECRET LIFE OF BEATRIX POTTER

JOURNAL OF BEATRIX POTTER. B. Potter. L. Linder, ed. Frederick Warne and Company, Inc., New York, 1966.

THE ART OF BEATRIX POTTER. B. Potter. Frederick Warne and Company, Inc., New York, 1955.

PLANTS WITHOUT LEAVES. R.E. Hutchins. Dodd, Mead and Company, New York, 1966.

THE ELUSIVE BOBCAT

THE BOBCAT OF NORTH AMERICA. S.P. Young. Stackpole Books, Harrisburg, 1958.

THE WORLD OF THE BOBCAT. J. Van Wormer. J.B. Lippincott Company, Philadelphia, 1964.

OF PREDATION AND LIFE. P.L. Errington. Iowa State University, Ames, 1967.

MAMMALS OF NORTH AMERICA. V.H. Cahalane. The Macmillan Company, New York, 1947.

ABOVE THE TREELINE

TIMBERLINE ANCIENTS. D. Muench and D. Lambert. Charles H. Belding, Portland, 1972.

ECOLOGY OF THE HEIGHTS. L.W. Swan. *Natural History*, April, 1963.

SURVIVAL ON A BLEAK SCOTTISH ESTUARY

BIOLOGY AND COMPARATIVE PHYSIOLOGY OF BIRDS, Vol. II. A.J. Marshall, ed. Academic Press, New York, 1961.

THE SHOREBIRDS OF NORTH AMERICA. G.D. Stout, ed. Viking Press, New York, 1967.

SOCIAL BEHAVIOUR IN ANIMALS. N. Tinbergen. Barnes & Noble, Inc., New York, 1965.

THE MINOAN CONNECTION

PREHISTORIC CRETE. R.W. Hutchinson. Penguin Books, Inc., Baltimore, 1962.

CRETE AND MYCENAE. S. Marinatos. Harry N. Abrams, Inc., New York, n.d.

FORGOTTEN SCRIPTS. C.H. Gordon. Basic Books, Inc., Publishers, New York, 1968.

UGARIT AND MINOAN CRETE. C.H. Gordon. W.W. Norton and Company, Inc., New York, 1966.

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Is the Galaxy Cracking Up

Huge clouds of hydrogen are falling into our galaxy at velocities of 50 to 100 miles a second. Until recently, some astronomers thought they were matter left over from the formation of the galaxy. Others offered the more interesting view that our galactic center is as active as others we see, and that it had shot out large quantities of matter, which had expanded into clouds that are now falling back in at the edges of our galactic disk.

R. D. Davies at the Jodrell Bank radio observatory in England has a better idea. In his view, the edges of the galaxy are being pulled out of the plane of the disk by the gravitational attraction of two small nearby galaxies, the Magellenic Clouds, visible to the naked eye in the southern sky. The tidal forces are so strong, in fact, that pieces are being broken off completely. It is these pieces, being pulled back by the stronger gravitational attraction of the galactic center, that radio astronomers see as incoming clouds of hydrogen.

Davies's explanation is based on a new survey of the outer reaches of our galaxy made with the Jodrell Bank radio telescope. Hydrogen clouds emit radio waves when their atoms spontaneously drop to a slightly lower energy level; the wavelengths of these signals appear slightly shifted as the clouds come toward us or move away from us. By measuring these shifts, radio astronomers can tell which way and how fast a hydrogen cloud is moving. They have mapped the movements of hydrogen clouds throughout the entire sky, and in so doing discovered the high-velocity clouds streaming into our galaxy.

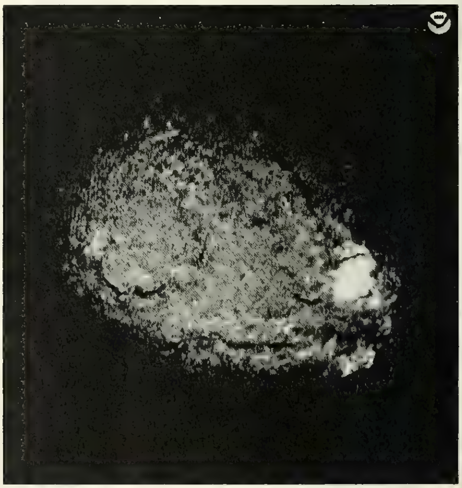
The Jodrell Bank survey has revealed the existence of spiral arms farther out from the center of our galaxy than any previously mapped. These more distant arms are tilted from the plane of the disk, and come quite close to the high-velocity clouds. The clouds appear to be broken off pieces of these distant arms; the distant arms themselves appear to be extensions of previously known arms.

Summarizing his results in *Nature*, Davies points out that his findings agree with earlier predictions by others that the galactic disk could be unstable at a distance of more than 16 kiloparsecs (a little more than 50,000 light-years) from the center. The new arms and the high-velocity clouds are beyond this at some 20 kiloparsecs (about 64,000 light-years).

Future textbooks will show the galaxy, not as a disk rotating in unassailable splendor, but as one whose edges are being flopped up and down hard enough to break off astronomical-sized chunks, which then fall back into the dense, seething center.

Dust from the Sun A common sight in high latitudes during the summer are noctilucent clouds, clouds so high (40 to 60 miles) that they remain illuminated long after the sun has set. They are believed to be composed of dust particles coated with ice.

Now it appears that the dust may come from the sun. The particles have been brought back to earth by high-altitude rockets, and they are revealing a strange chemistry that is almost certainly not terrestrial, meteoritic, or cometary in origin. Some 70 percent of the particles have inner cores of heavy, exotic atoms of such elements as lanthanum, thulium, praeseodynium, osmium, ytterbium, and tantalum. The rounded, low-density material that surrounds some of the cores ap-



In this picture of the sun through a special filter, a bright flare appears near right center as a white splotch. The flare, which reached a peak on August 7, was one of the largest ever recorded, covering some 2.8 billion square miles. Particles ejected from the sun in flares like this reach the earth; some of the heavier particles may form the nuclei for the high-altitude ice crystals we see as noctilucent clouds.

by John P. Wiley, Jr.

pears to have been in place before the particles entered the earth's atmosphere, although it may have been altered during entry.

Reporting their results in *Nature,* Curtis L. Hemenway, D. S. Hallgren, and D. C. Schmalberger of the Dudley Observatory in Albany say the particles almost certainly are coming from outside the earth because other rocket flights have found that the particles have measurable downward velocities. They also feel that if the particles were terrestrial, it would be hard to explain why only such heavy, unusual elements are found. They are satisfied that the particles were not from their laboratory and are not part of the rocket or its exhaust.

The same argument about the preponderance of heavy atomic weights seems to rule out the moon, meteors, asteroids, or comets as the source. The flux seems too great to be interstellar in origin. Thus the authors find they are left with the sun as the only possible source.

A solar origin for the noctilucent cloud particles could also explain observed variations in the Zodiacal Light. This hazy cone of light, sometimes visible after sunset or before sunrise, is sunlight reflected from dust particles in orbit around the sun. At times when increased solar activity is producing more of the heavy particles, the Zodiacal Light would naturally be increased.

Their suggestions, the authors say, have several implications. The reason tropical skies are darker may be because the solar particles, carrying an electric charge, are preferentially drawn toward the earth's magnetic poles. Thus our atmosphere may have a fixed lower limit of cleanliness, a limit always to be found at low latitudes. Inflow of these particles could also have a bearing on terrestrial weather. The particles would make effective nucleating agents for rainfall when they reach the troposphere. Thus long-range weather forecasting may need to take into account the upper atmosphere influx of solar dust, which presumably is based, in turn, on varying solar activity.

More on Black Holes I had always thought that black holes (stars so collapsed, with gravity so strong, that no light can escape) were more or less invented by J. Robert Oppenheimer (he of the later AEC hearing) in 1939. Not so. In a review in *Nature,* Roger Penrose of Birkbeck College, London, points out that in 1798 Pierre Simon La Place, the French mathematician, wrote that the largest luminous bodies in the universe may be invisible. According to his calculations, "A luminous star, of the same density as the Earth, and whose diameter should be 250 times that of the Sun, would not, in consequence of its attraction, allow any of its rays to arrive at us."

Today black holes are the object of a widespread hunt. In 1971 at least ten authors proposed that the invisible companions of stars in certain binary systems could be or must be black holes. Such arguments illustrate one of the few ways to detect a black hole: by its gravitational effect on another body.

Another way to find them is to detect the gravitational waves they would generate, particularly when black holes merge or when entire stars are pulled into large black holes. Very strong gravitational waves have been detected coming from the center of our galaxy, leading some theorists to postulate that a large black hole at the center is swallowing stars continually.

If one is found, it would not behoove a future physicist to get too close. An observer approaching the threshold of a black hole of one solar mass can expect to feel himself stretched in the direction of the center of the hole and squashed in all the perpendicular directions. These forces would be enough to kill a man, Penrose notes, long before he reaches the hole.

Falling into a black hole of 100,000 to 100,000,000 solar masses, the observer would not be killed until he was well inside the hole. "But," Penrose continues, "as he nears the center, the effect mounts inexorably. Not only is the observer himself soon destroyed by the mounting space-time curvature, but the very atoms of his body, even their constituent elementary particles, will themselves be ultimately squeezed out of existence."

The final state is a "space-time singularity," an area in which space and time have become so distorted that the laws of physics as we understand them no longer apply. Penrose points out that some theorists believe some matter may be able to escape from a black hole: for example, if an extremely asymmetrical body collapsed, some parts might miss other parts. This matter, he says, could escape the black hole but not the space-time disruption and would emerge as a visible or "naked" singularity. For these objects, too, the physics is unknown, and Penrose suggests that extraordinary things could occur, "For example, the production of matter out of gravitation."

Black-hole hunters should work out what the detectable characteristics would be, Penrose argues, for the possibility of naked singularities must be taken as seriously as that of "normal" black holes.

Celestial Events

by Thomas D. Nicholson

The Moon: From first-quarter on October 15, the moon goes through its waxing gibbous phase, during which it is prominent in the evening sky, growing in size nightly, and setting later and later after midnight, until it becomes full moon on October 22. This full moon is known as the hunter's moon. Like the harvest moon of September, the moon this October, as it nears its full phase, rises only a half hour or so later each night, as compared with an average of 50 minutes later nightly at other times. Thus, the full or nearly full moon seems to be in the sky all night long for several nights in a row during early autumn.

After full moon on the 22nd, the gibbous moon wanes nightly, while rising later and later after sunset, until it becomes the last-quarter moon on October 28. The waning crescent continues to be seen in the morning sky until a few days before new moon on November 5. By November 8, you should begin to see the new crescent moon in the evening sky, growing in size and becoming first-quarter on November 14.

Stars and Planets: In these months of early autumn, the early evening sky still contains the brightest summer stars, the Great Triangle of Altair, Deneb, and Vega, well up in the west. Stars of autumn, in the constellations Pegasus, Andromeda, Perseus, Cassiopeia, and Aries, are high above, while winter stars, led by those of Auriga, Taurus, and Orion, are rising in the east. By midnight, the stars of winter fill the eastern sky, moving into the west during the morning hours.

Jupiter and Saturn appear among the evening stars. Jupiter, in Sagittarius, is very bright in the southwest at dusk, but sets shortly after dark, along with the southern summer stars. Saturn rises in Taurus several hours after sunset, appearing well up in the southeast by midnight.

The morning sky contains Saturn and Venus. Saturn is still high in the southwest at dawn. Venus, much brighter, is in Leo, and rises between 2 and 3 hours before the sun, disappearing with the dawn.

Meteors: The outlook for viewing the Orionid meteor shower, which reaches maximum on October 21, is not good, with bright light from the full or nearly full moon expected all night long. Moonlight will not interfere with observations of the Taurid meteors, however, as they approach their maximum on November 4. But this is a sparse shower of not too bright meteors.

October 23: Perigee comes 24 hours after full moon. Expect greater high-water heights from perigee spring tides.

October 25: Saturn rises shortly after, close to, and below the moon tonight.

November 2-3: Venus is near the crescent moon on both mornings, to the left of the moon on the 2nd, to the right of the moon in the dawn sky on the 3rd.

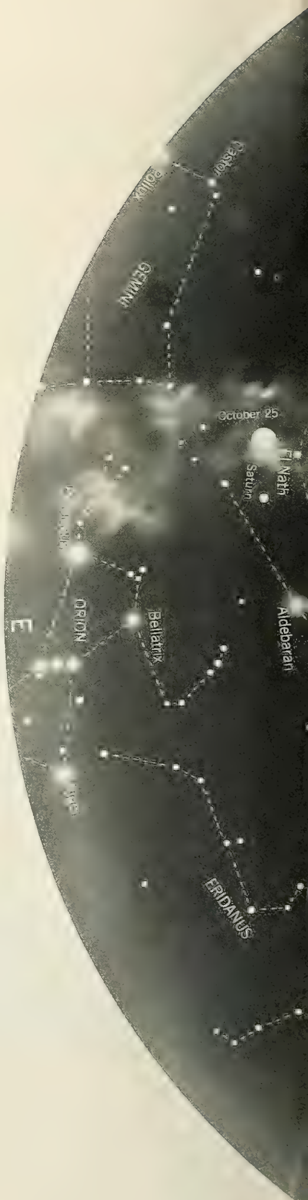
November 4: If you look carefully to the left and above the rising crescent moon, you may get your first glimpse of Mars as a morning star today. The star Spica is between Mars and the moon.

November 5: Mercury is at greatest elongation to the left of the sun in the evening sky, but this is an unfavorable elongation. The planet is quite low even at sunset.

November 9-10: Jupiter is close to the moon on both evenings. At conjunction, on the 10th, the moon occults the planet over Antarctica.

November 15: Mercury begins its retrograde (westward) motion.

★Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:20 P.M. on October 15; 9:20 P.M. on October 31; and 8:15 P.M. on November 15; but it can be used for about an hour before and after those times.

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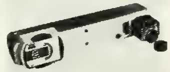

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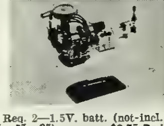

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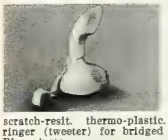

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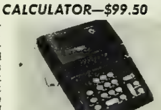

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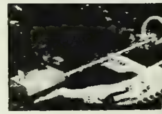

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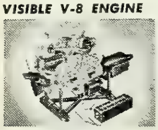

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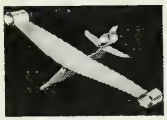

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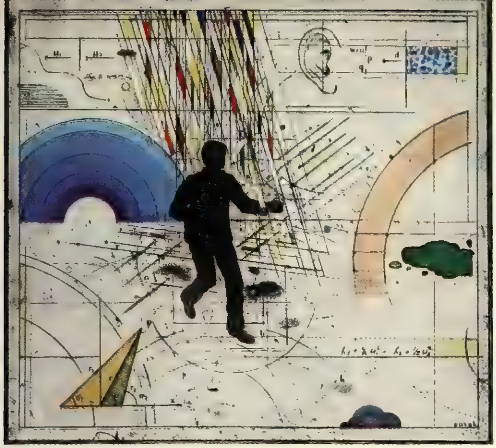

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The American Museum of Natural History

Gardner D. Stout, President — *Thomas D. Nicholson, Director*

Vol. LXXXI, No. 9 — November 1972

COVER: *Out of Inca antiquity come Peru's modern manipulators of bell, book, and candle. A young man intently listens to a* curandero *who seeks advice from a deck of Spanish divining cards.*

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Authors

Raised on a dairy farm in Tennessee, **Lisa Alther** had an early interest in the debate over organic versus chemical farming. A vegetable garden in her backyard sharpened her desire to find validity in the flood of conflicting claims and statistics emanating from both camps. Alther, a free-

Lisa Alther

lance writer, visited England last year to look into agricultural techniques in that country, particularly at the Haughley Research Farms in East Anglia.

Douglas G. Sharon first met Eduardo the folk healer while on an archeological expedition to northern Peru in 1965. Impressed by the man and his talents, in 1970 Sharon obtained a fellowship to investigate *curanderismo* and its role in contemporary Peruvian culture. To gain insights into the subject, he became Eduardo's apprentice. Sharon, a teaching assistant at the University of California

Douglas G. Sharon

at Los Angeles, plans to study the psychology of socialization among the Guajiro Indians of Venezuela and Colombia.

A design instructor at the Cleveland Institute of Art, **Christopher Williams** believes that "wood is perhaps the material closest to man's own temperament. It is infinite in its variety, vital, and filled with imperfections." To learn about the harmony between woodworkers and their environment, he has visited North Africa, the Middle East, eastern Europe, and Lapland, and watched native craftsmen and architects at work. Williams, who is completing a book on his observations, is a carpenter by avocation.

Christopher Williams

Whether he is speaking to fish hobbyists or marine scientists, **James W. Atz** emphasizes the extremely delicate nature of fishes. But he hastens to add that they

James W. Atz

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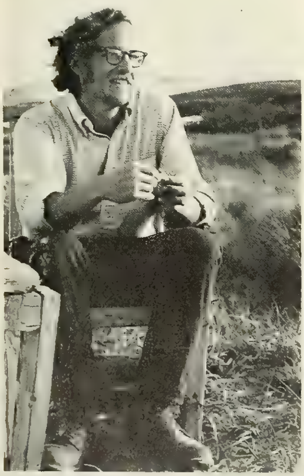
are not really difficult to keep once their sensitivities are understood. Atz had ample firsthand experience with the problems of keeping fish in captivity while serving on the staff of the New York Aquarium for nearly 25 years. His research has included work on the reproductive behavior, endocrinology, and genetics of fishes. He is a curator and Dean Bibliographer of Fishes in the Department of Ichthyology at The American Museum of Natural History, and an adjunct professor of biology at New York University. His latest book, illustrated by photographer Douglas Faulkner, is *Aquarium Fishes*, published last year by The Viking Press.

For the past six years **Derek Stonorov** has studied the social behavior of the Alaska brown bear. Most of his field work was carried out at the McNeil River Bear Sanctuary and Lake Becharof on the Alaska Peninsula while Stonorov was a graduate assistant in the Department of Wildlife Resources at Utah State University. He has now moved to Fairbanks to be closer to the bears, and to continue his long-term research on the communica-



Derek Stonorov

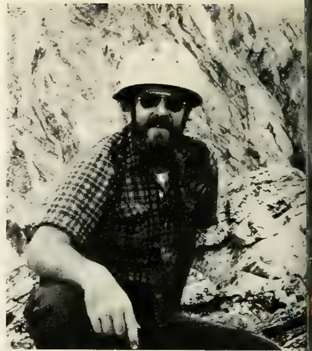
tion used by bears to establish hierarchies during the salmon feeding season. His wife, Molly, assists in the data collection and photography, and shares her husband's enthusiasm and concern for the life history and survival of the brown bear.

John T. Hardy first saw colored snow in 1964 while mountain climbing in the Cascade Mountains of Oregon. The striking phenomenon spurred his interest, and he soon became involved in research to learn more about how organisms could thrive in such a severe environment. Hardy's other research interests have involved studies of the ecology of the giant *Tridacna* clams, life cycles of the microscopic organisms that inhabit air-water interfaces, and sewerage pollution in tropical

John T. Hardy

lagoons. He has just begun an assistant professorship in biology at the American University of Beirut, Lebanon, where he plans to initiate a study of marine pollution in the eastern Mediterranean.

Coauthor of "The Candy-Colored, Snow-Flaked Alpine Biome," **Herbert Curl, Jr.**, is a mountain climber, which helps him in his studies of snow algae. He has investigated algal growths in the snowfields of the Cascade Mountains with John Hardy, and made expeditions to Antarctica and the glaciers of Alaska. Marine productivity is his other specialty, and his next project will center on estuarine ecosystems. Curl is professor of biological oceanography at Oregon State University.



Herbert Curl, Jr.

"There are few things more presumptuous than a U.S. scientist holding forth on the future of tropical ecology," explains **Daniel H. Janzen**, who since 1963 has spent three to six months of every year conducting ecological studies in Central America. "But," he adds, "I am here by default. The fantastic diversity of resources and cultures in the tropics is singularly lacking in indigenous scholarly exposition." Janzen's recent

Daniel H. Janzen

work has been centered in Costa Rica, where he is studying the interactions of animals and plants in both natural and disturbed habitats. Associate professor of zoology at the University of Michigan, Janzen has also traveled to Africa and Southeast Asia to pursue tropical studies.

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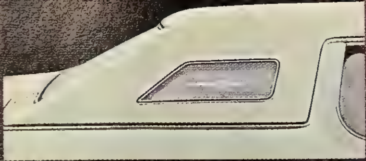

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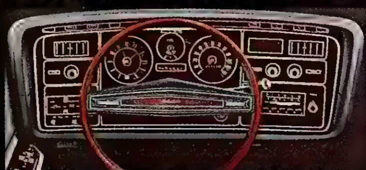

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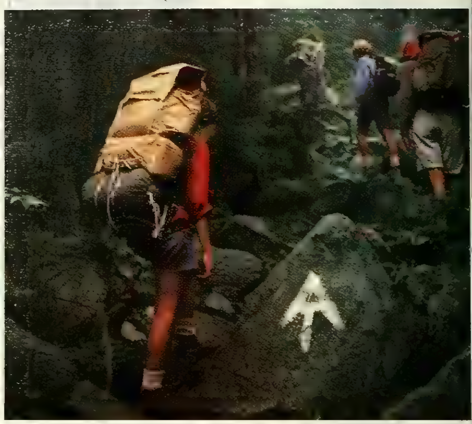

And to a *lot* of people.

To begin with, four million individual Americans own 39% of the entire forest—a forest that's still three-fourths as large as it was when Columbus landed.

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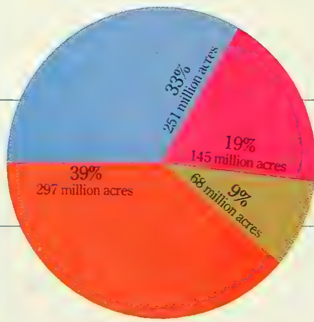

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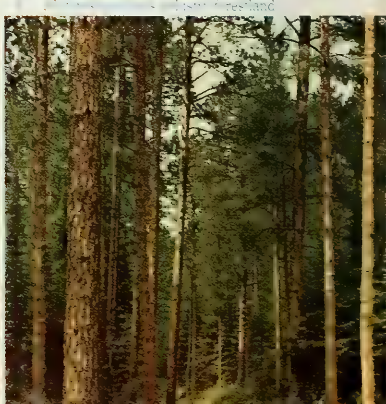


Letters

What's New At the Zoo?

Robert Sommer's recent article in *Natural History* ["What Do We Learn at the Zoo?" August-September, 1972] raises some interesting and provocative questions about the scope and purpose of zoos in modern, urban society. Yet I feel that part of his criticism is misplaced.

No one is more critical of zoos than members of the zoo world itself. The innovative ideas being developed by the major zoos of the country should leave no doubt that zoos are undergoing painful analysis and re-evaluation.

Most zoos, aware of the inadequacy of many of their cagelike exhibits, are undergoing an extensive modification of existing facilities and are adding sizable open exhibits. Hidden moats are being used to restrict animals to specific areas. There is a tendency toward exhibits that simulate the animal's natural habitat.

Yet despite all the changes, Dr. Sommer is quite correct that most zoos fall short in their role as educators. The zoo must offer learning experiences to every age group. It must educate the public to the idea that we, as humans, are only part of a biological community that must be treated with love and respect if it is to endure.

Since its opening in 1966, the Los Angeles Zoo has been involved in a comprehensive and wide-ranging education program. Most importantly, Los Angeles is not unique. Many of the major zoos have special projects and personnel devoted . . . to the problems of educating the public through specially coordinated classes and improved graphics.

Zoos are intensely interested in education and committed to the development of extensive programs that will offer the public an understanding of the importance of preserving wildlife as a valuable and diminishing resource. For only through changing the value system of the urban society will the biological community endure.

Sharon B. Emerson
Assistant Curator of Mammals
Los Angeles Zoo

Points of View

I personally felt that "Conception and Contraception," by Gerald Oster [August-September, 1972] was out of place in your magazine—although advanced and well written. However, what really bothered me was the accompanying photograph of the various methods of birth prevention.

Jacqueline E. Beckmann
Staten Island, New York

I must convey to you my continued pleasure with the magazine, its scope of coverage and illustrations. I was particularly impressed by the artful treatment of the illustration facing Gerald Oster's article.

Stuart J. Coward
Department of Zoology
University of Georgia

Hungry Beavers

In his article, "Return of the Beaver" [June-July, 1972], John W. Miller states that pines are the only type of trees beavers will never fell or eat. I have been studying the food choices of beavers in Worcester County, Massachusetts, this summer, and have found one beaver colony that has cut and debarked white pines and another colony that has stripped the bark from the bases of several red pines. A third colony has shown no evidence of using pines so far this year.

The contrast between Miller's experience in western Massachusetts and mine in central Massachusetts suggests that there may be significant differences in food habits between different colonies of beavers.

Stephen H. Jenkins
Department of Biology
Harvard University

One Man's Food Is Another Man's Whitewash

Only a peculiar minority of the world's adults drink milk

If you are a typical American, you will find it hard to believe that the world is full of people who get sick when they drink milk. When we milk lovers were young, our parents told us that milk was nature's perfect food. Soon, merely to be in the presence of a brimming glass of fresh milk was to feel nature's goodness and to have visions of radiant health dance in our heads.

As adults, we milk lovers continue to drink a glass or two a day, especially when in need of extra strength or purity, after an illness, or to combat a hangover. A breakfast of cereal and milk starts the day right, and additional milk goes into our coffee even if we don't order a "grade A" at lunch.

But the milk-tide of American life runs strongest in childhood and adolescence, when all sorts of ingenious shakes and malteds are gulped down in addition to the nutritionally recommended quart a day. How incredible, therefore, that there should be vast numbers of people in east Asia, Africa, and South America who regard milk as a food unfit for consumption by adult human beings.

In many cultures, the rejection of milk as an adult food is accompanied by a definite loathing. The Chinese, for example, react to the thought of a glass of milk the way we might react to the thought of a glass of blood.

It seems perverse that humans should deny their evolutionary heritage by spurning the life-giving product of a fellow mammal's mammary glands. But this is an illusion produced by our own customs. If we are to judge whose tastes are peculiar by general mammalian standards, it is the Americans and Europeans, not the Chinese, who seem peculiar. Adult mammals, in general, don't drink milk. More importantly, most adult mammals have trouble digesting milk.

Milk presents a problem because its only significant carbohydrate, and its predominant solid, is a complex sugar known as lactose. Before lactose can be metabolized, it must be converted from a complex to a simple sugar. This conversion is effected by an enzyme known as lactase, which is produced by the lining of the small intestine. If the level of lactase production is inadequate, ingestion of substantial amounts of milk leads to flatulence, bloating, and diarrhea. During infancy, adequate lactase levels are maintained until weaning, but in animal experiments it has been found that lactase production declines or ceases altogether among juveniles and adults. Lactase production in rats, for example, begins to decline about two weeks after birth; juvenile pigs fed on lactose fail to thrive; and when adult dogs are given milk, it induces diarrhea. I think it likely that the inhibition of lactase production is an evolutionary adaptation that discourages juvenile and adult mammals from competing with infants for mother's milk.

The principal known exceptions to the rule that adult mammals are lactase deficient appear to be the lactophilic populations of Europe and America and the domesticated cat. Many individual adults in these groups, however, show symptoms of discomfort and diarrhea after milk consumption.

A recent study by Robert McCracken, professor of public health and anthropology at the University of California, Los Angeles, indicates that human populations differ greatly in their proportions of lactase-deficient individuals. More than 90 percent of adult Thais, Taiwanese, Andean Indians, and Eskimos have clinically established lactase deficiencies, while similar deficiencies seem to occur in less than 20 percent of the populations of such European centers of dairying as Finland, Sweden, and Switzerland. In the United States, the rate for lactase deficiency among adults of predominantly European ancestry lies between 10 and 20 percent, contrasting with the 70 percent rate found among adults of African descent.

These facts have only recently been brought to the attention of Western nutritionists and development experts, whose first impulse when confronted with a substandard diet has been to try to increase the milk ration. I think there is little reason to doubt that thousands of tons of powdered milk sent out to benefit people in underdeveloped countries result in increased gastric distress rather than improved nutrition. Anthropologists and others who have lived in peasant areas have long reported a variety of complaints associated with the distribution of milk by relief agencies. In Brazil, I was frequently told that drinking powdered milk was no good because it caused stomachaches. Professor McCracken has collected a number of similar cases: abdominal pains following distribution of powdered milk in Vicos, Peru; powdered milk deemed fit only for whitewashing houses in Guatemala; powdered milk deliberately thrown away by the Navahos; high absenteeism among Colombian schoolchildren after the arrival of powdered milk shipments from the United States; refusal by the Kanuri of Nigeria to use powdered milk because of the "evil spirits" in it; and use of milk as a laxative among the Balinese.

Two major hypotheses have been offered to explain the distribution of lactase-deficient and lactase-sufficient adults. Professor McCracken believes that all human populations were originally lactase deficient. With the development of cultures that depended primarily upon dairying for subsistence, adult individuals who could metabolize milk enjoyed a reproductive advantage over those who could not. This resulted in populations that were genetically adapted for milk consumption by juveniles and adults.

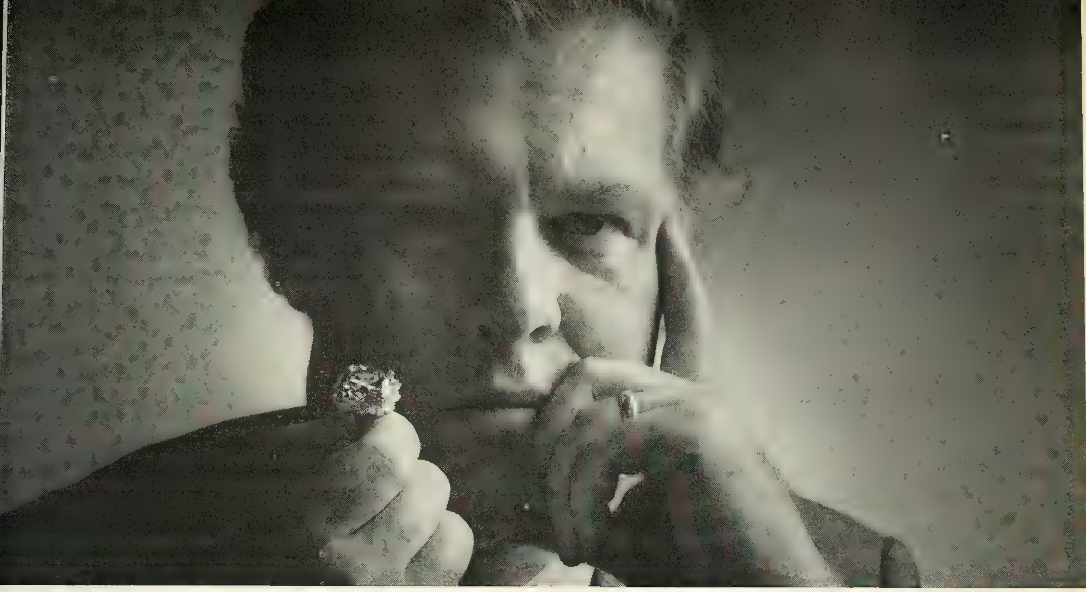
Opposed to this genetic hypothesis is one that stresses environmental factors. Some investigators believe that all human populations can achieve high rates of lactase sufficiency if during the transition from infancy to adulthood they indulge in the uninterrupted consumption of substantial quantities of milk. Others point to the inhibiting effect of diseases and parasites on the intestinal mucosa that secrete lactase, and suggest that when these diseases are controlled, most people can produce sufficient lactase.

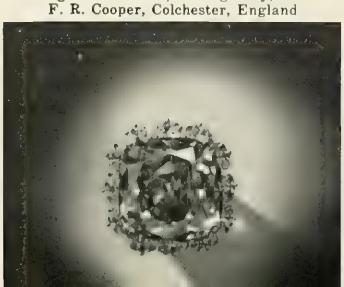
I am personally inclined not to accept the genetic theory because there are alternative modes of ingesting milk products that avoid the need for lactase. When milk is fermented, converted into cheese, or boiled, most of the lactose is broken down into simple carbohydrates. It seems likely to me that wherever the consumption of milk was vital for health and reproduction, lactase-deficient individuals would avail themselves of these cultural adaptations.

Hence, where dairying was important for subsistence, there would be no cause for lactase-deficient individuals to be reproductively less successful than lactase-sufficient individuals, and consequently there would be no genetic selection for lactase sufficiency. It seems to me more likely that the factors accounting for the variance and distribution of lactase deficiency are related to contemporary systems of food production and to the availability of quantities of milk sufficient to maintain lactase levels during the transition from infancy to adulthood. Much additional research will be required before we can make an informed choice between these alternative interpretations.

In any event, a new perspective has been opened on the question of why people such as the Thai and Chinese have an aversion to milk. Robert Lowie, one of the most distinguished anthropologists of an earlier epoch, attributed such food preferences to arbitrary and essentially inexplicable cultural standards. It now seems assured that this trait, like other seemingly arbitrary cultural preferences, is determined by definite interactive processes that link culture, man, and nature into an intelligible system.

Columnist Marvin Harris teaches anthropology at Columbia University.





Organic Farming or

For 34 years organic and chemical agriculture have been compared on a British experimental farm

by Lisa Alther

Amid the loud and often outrageous claims being made in the United States by the organic school of farming on the one hand, and the agrochemical businesses on the other, it is refreshing to come across a group of people (where else but in England?) who for the past thirty-four years have been calmly and quietly studying the soil-plant-animal cycle and the effect of different agricultural methods on this cycle.

Haughley Research Farms is located in the flat agricultural region of East Anglia, near the old market town of Stowmarket and some two hours by train northeast from London. Walnut Tree Manor, a handsome old brick house, serves as headquarters for the Soil Association, which has run the Haughley Farms until recently, and for the Pye Research Centre, which now runs the farms. The Soil Association is a private organization with an international membership whose purpose is to undertake research into the relationships among soil, plants, animals, and man, and to disseminate the results. The Pye Research Centre is a charitable trust with goals similar to those of the Soil Association, based on the convictions of Mr. and Mrs. Pye that the increasing incidence of degenerative disease in developed countries requires some basic research into human nutrition.

In the late 1930s and early 1940s there was a surge of interest—similar to today's—in the countryside and the soil. People were moving back to the land in search of a way of life that would make sense and provide some small measure of security in a world seemingly gone mad. This train of thought naturally led a great many people to an interest in the whole topic of farming.

At the time, three Englishmen, working in different fields, arrived at similar conclusions. Dr. Lionel Picton, a general practitioner in Cheshire and one of the authors of *The Medical Testament*, maintained that "illness results from a life-time of wrong nutrition . . . for nutrition and the quality of food are the paramount factors in fitness." Sir Robert McCarrison, by feeding rats the diets of different human populations, claimed in his book *Nutrition and National Health* to have duplicated in the rats the diseases that were prevalent in each population group. Sir Albert Howard's lifetime of agricultural work had led him to the conclusion that the quality of food related in general to the fertility of the soil in which it was grown, and in particular to the well-being of the microflora in that soil.

Picton, summing up the joint observations of the three men, said in *The Medical Testament*, "The Eskimos on flesh, liver, blubber, and fish; the Hunza or Sikh on wheaten chapaties, fruit, milk, sprouted legumes and a little meat; the islanders of Tristan da Cunha, on potatoes, seabirds' eggs, fish and cabbage; are equally healthy and free from disease. But there is some principle or quality in these diets which is absent from, or deficient in, the food of our people today . . . . The food in all these diets is, for the most part, fresh from its source, little altered by preparation, and complete . . . in the case of foods based on agriculture, the natural cycle is complete. Animal and vegetable waste-soil-plant-food-animal-man. No chemical or substitution stage intervenes."

It was to study these last two factors—a complete cycle using all organic wastes and the elimination of chemical substitutes for natural processes—that Miss Alice Debenham and Lady Eve Balfour donated land and set up the Haughley Experiment, named for the small English village of Haughley in which the farms are located. Even at that time there were abundant testimonies from people who claimed to have been cured of various ills, or to have increased their resistance to ills, by switching to organically grown food. There were farmers who, upon a change to organic farming methods, thought they had noticed an end to deficiency diseases in their livestock, equivalent production per animal on less food, better breeding records, and increased longevity. Other farmers felt they had witnessed greater crop

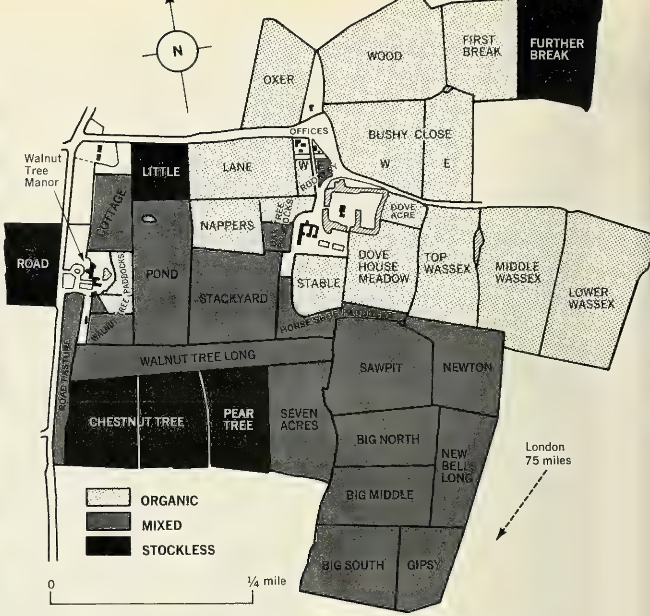
Trial

resistance to deficiency diseases and to pests under organic husbandry, qualities that increased in successive generations.

Yet no one had ever systematically studied this topic of disease as a symptom of imbalance between an organism and its environment. And for obvious reasons. It is a project whose scope Michael Allaby, editor of the English environmental magazine *The Ecologist*, now terms "almost naively ambitious."

In answer to criticism that the size and scope of the Haughley Experiment were too great to allow valid statistical treatment, Reginald F. Milton, consultant biochemist to the experiment, said in their report of the first twenty-five years, "My experience in the wider biological field had taught me, also, the limitations of the statistical approach. The statistical formula is valid only if the number of variables is known and limited, and in any experiment involving a biological organism the variables can never be assessed—let alone controlled. . . . Now the Haughley Experiment is concerned with differing methods of farm management and it involves the complicated interplay and balance between soil, crop, and animal. The limits are boundless and cannot be anticipated or controlled. The experiment, therefore, is to be considered as a pioneer or proving venture, which may reveal effects upon soil, plant, and animal that could never have been obtained by plot or controlled agricultural experiment." Also, eliminating any known variables in an effort to fashion a statistically valid experiment would have destroyed the "whole" the experiment was designed to study.

The alkaline clay-loam land provided by Miss Debenham and Lady Balfour was divided into three sections, chosen carefully so as to allocate equally the different soil types, variously oriented fields, etc. The organic section consisted of 68 acres of crops and pasturage and 7 acres of permanent grass. The rotation was one year each of wheat, kale and maize, barley, peas and beans, oats, silage, then four years



Haughley Research Farms

of pasturage. Seed from each crop of wheat, barley, oats, peas, and beans was saved for the next year. No sprays or seed dressings were used. Guernsey cattle, Clum Forest breeding ewes, and Light Sussex poultry were kept; their manure was roughly composted and returned to the fields, along with crop residue, at an average annual rate of three to five tons per acre. Animals were fed almost exclusively on the above feed. Herd or flock improvement was achieved solely through home breeding and culling of the descendants of the original animals. Milk and eggs were sold. No injections, stimulants, or hormones were given to any animals.

The mixed section of 75 acres was managed similarly with respect to the cropping system and the livestock. Here, the crop residues and the manure, piled briefly or spread directly on the fields, were supplemented by conventional applications of artificial fertilizers. Herbicides, pesticides, and seed dressings were used as needed. The cows were provided with supplemental mineral mixes and the chickens with fishmeal, whereas the animals on the organic section received seaweed supplements.

The stockless section, as the name indicates, supported no livestock. It consisted of 32 acres of arable land with the rotation being wheat, sugar beet, barley, beans. Crop remains were supplemented by artificial fertilizers. Sprays and seed dressings were used. This section most closely resembled the common commercial monoculture typical of East Anglia. ("The rotation here is barley, barley, barley," jokes Brigadier A. W. Vickers, general secretary of the Soil Association.) In addition to the three sections just described, there was a research area for running tests on soil and crop structure and content.

As of 1971, the organic and mixed sections had completed two full ten-year rotations, which means that every field had grown every kind of crop and had gone through its full period under pasture on which all the different kinds of stock had grazed. The stockless section had completed some four rotations, having no livestock and therefore a shorter rotation period. To iron out variations due to unusual weather, rainfall, or other local conditions, it was thought necessary to complete one full rotation before indicating any trends.

In general, the fields on the organic section seemed to exhibit a greater "workability" to the farm hands. For example, in the spring

of 1961 the tractor plowman reported the following fuel requirements for plowing at the same setting one field in each section during the first week that the land would carry a tractor: the stockless field, 9 gallons per day; the mixed field, 7 gallons; and the organic, 5 gallons. This difference may be explained by the greater humus content, and hence porosity, that the organic fields attained during the first rotation and a half.

Another interesting observation resulting from monthly soil tests over the years is that the humus content and several of the minerals and trace elements exhibited a seasonal pattern of rise and fall, reaching a peak in availability during the late spring and summer months. A similar seasonal fluctuation in vitamin, mineral, and protein content appeared to pertain in the case of herbage, milk, and eggs from the various sections. This suggests a correlation between enhanced biological activity in the soil, which releases bound minerals, and most rapid plant growth. Such fluctuations appeared to be largest and most consistent in the fields with the highest humus content, those of the organic section. All of this suggests, among other things, the futility of assessing soil requirements on the basis of one annual soil test, as is often done in the United States.

Despite the application of artificial fertilizers containing nitrogen and phosphate to the stockless and mixed sections, the organic section showed a higher level of available nitrogen and phosphate. This might indicate a loss of the applied nitrogen by leaching or volatilization. Milton urges caution in interpreting these facts, but would go so far as to say in 1964 that "the picture is sufficiently clear to indicate that on the organic section, which is not treated chemically, there is no nutritional deficiency."

As for the crops on the three sections, there was a greater yield from cereal crops on the mixed and stockless sections, but no clear pattern emerged concerning the yields of other arable crops. There was also some indication of a greater resistance to insect pests on the organic section. In 1960–61 only heavy spraying saved the pea and alfalfa crops on the mixed section from complete devastation by wee-

vils, whereas neither the alfalfa nor the peas on the organic section were attacked. The mixed section's oat-pea silage for 1961 was not sprayed, and weevils destroyed practically every pea, whereas almost no damage occurred to the unsprayed organic section's silage.

From the third generation of cereal crops on, a marked difference was noted in terms of large grains versus small during the sieving of the grains for seed purposes. The stockless section yielded 10 percent "smalls," the mixed 7 percent, and the organic 5 percent. Another interesting trend was the increasingly "self-supporting" nature of the organic section crops. A 1962 report said, "Those on the other two sections are definitely dependent on the artificial aids they receive. . . . If fertilizer is omitted from even a small area of any field, the yield of that part of the crop drops well below the yield of the equivalent organic crop. Conversely, the heaviest-yielding fields on the organic section are those that have been *longest* without fertilizers." In the spring of 1961 the mixed section alfalfa pasture produced a large number of discolored leaves, which disappeared only after the addition of artificial fertilizers, whereas the organic section alfalfa produced only a few isolated leaves with such discoloration.

The most dramatic result of the thirty-four-year experiment, though, is that the cows on the organic section gave significantly more milk on 10 to 15 percent less feed than the cows on the mixed section. Since both sections were self-supporting, with no feed brought in from outside, and since the crops on the organic section had a lower yield than those on the mixed section, the organic section cows had smaller feed rations; even so, they outproduced the mixed section cows in total milk production, production per cow, production per acre, and production per pound of concentrates fed. This finding has occupied a great deal of research and thought at Haughley. A controversy arose among Soil Association members in 1962 as to whether genetic factors in the two herds could account for the difference in milk production. This led to a close study of the herds' histories and to the dismissal, apparently with the plaintiffs' ap-

One of the original houses still stands at Haughley Farms, site of a British organic farming experiment.

proval, of the original herd allocations as an explanation for later trends in productivity.

When the mixed section fields were being fertilized artificially in the spring of 1963, a strip across the center of one field was deliberately left unfertilized. Once the cows were turned into this field, they immediately sought out this unfertilized strip and grazed it bare. Chris Sharman, assistant farm manager, says that he observed that the cows on the organic section always grazed their fields closely and evenly, whereas the cows on the mixed section grazed patchily, leaving tufts of coarse grass all through their fields. Whether this was a question of palatability, nutritional content, or what, remains unclear.

Milton has suggested that perhaps the higher solids content of the organic pastures accounts for the phenomenon of more milk for less bulk of feed: the mixed pastures produced grasses containing a higher moisture content. Therefore, the mixed section cows would sometimes have had to eat twice as much bulk as the organic section cows in order to ingest the same quantity of actual dry matter.

In terms of the vitamin and mineral content, there seems to have been no significant difference in the mixed and organic crops fed to the respective herds that would account for this difference in their milk production. There were, however, more trace elements in the seaweed fed to the organic cows than in the mineral mix given to the mixed cows; also the pastures on the organic section contained many deep-rooting herbs. The protein content of crops from the organic section was slightly higher as well. But on the whole, Milton feels that they have not yet accounted for greater milk production for less food tonnage on the organic section. He says, "We have been for the past few years carrying out regular analyses of the crops and produce from the sections. These analyses have included the usual items of recognizable food value, as well as mineral content (including trace elements) and also certain of the vitamins. There is more than inferential evidence that, in addition to these factors . . . certain substances may be present in foodstuffs that affect palatability, digestibility, and assimilability, and that could represent an important part of the nutritive value that would be included under the heading of quality." An experiment to explore such factors was carried out in 1963 on fistulated heifers—cows with tubes fixed into their rumen so that samples of partly digested food could be removed at intervals and examined for bacterial flora and fatty acid composition. Indications from this experiment and from others at English agricultural research stations in recent years are that different diets produce different ratios of simple organic acids (such as acetic, propionic, and butyric), which affect synthesis of butterfat in the udder. But at this point Milton is reluctant to interpret these results in relation to the higher milk yields on the organic section.

In addition to a better milk production record, the organic herd had a better breeding record than the mixed herd. From 1948 to 1964, 17 percent of the cows culled from the organic herd had failed to breed; this figure was 34.8 percent for the mixed herd.

Expenses and income at the Haughley Farms obviously aren't comparable to those of commercial farming, where feed is often bought and where yields can be increased through different seed varieties and through animals imported from outside. Also, because of the careful measurements and separations performed for research purposes, labor costs are higher at Haughley. But the sections were carefully costed separately in order to find out if, under the conditions of the experiment, the organic section would be much more costly to run, as had been predicted. This was not the case. Total costs for the organic and mixed sections were equivalent, *excluding* fertilizers; thus, the mixed section cost more to run by roughly the amount spent on fertilizers.

Despite many of these results, which seem to suggest the superior-

ity of the methods used on the organic section, the Haughley Experiment must really be termed a stalemate. By 1965 there was evidence that the organic section was running down. Crop yields began to flag and the herd had to be reduced; as a result of less crop residue and less manure to be turned under, humus content of the soil also started to drop. The remaining cows on the organic section began to suffer from certain mineral deficiencies and were plagued by infertility. One explanation for this is that the circle at Haughley was not really a closed one: milk, eggs, and animal carcasses were removed from the farm with no equivalents being returned to the land on the organic section, whereas commercial fertilizers replaced nutrients removed from the mixed and stockless sections. For this reason, in 1970 it was decided to conclude the attempted "closed cycle" phase of the experiment by carting in from the outside carefully selected chicken manure for the organic section. At the same time the researchers decided to study methods for upgrading depleted soils.

One often hears the claim that organically raised animals are disease resistant. Sir Albert Howard had oxen who rubbed noses with oxen suffering hoof-and-mouth disease and yet his animals did not succumb to the disease. In the late 1960s fowl pox completely destroyed the chicken flock on the mixed section at Haughley, as it did chicken flocks all across England. For some three months the flock on the organic section remained healthy. On the day that government agricultural officials were to arrive to witness this phenomenon, however, the first chicken in the organic flock succumbed to fowl pox, with the rest of the flock soon following. This would suggest that resistance based on an organic diet could be a factor in avoiding disease, but certainly not the only one.

Robert Waller, editor of the *Soil Association Journal*, said in a review recently, "There is no superiority of any manure just because it is natural or organic: in practice, everything depends upon its composition, nothing on its origin. For the plant to make the fullest use of the radiant energy of the sun, the topsoil must contain the full range of substances required for its metabolism. Here the art of husbandry comes in, backed up by scientific information. On both the organic and mixed sections of Haughley we should be able to practice this according to the different methods of husbandry. . . . It does seem to me, however, that to provide plants with a balanced diet by the use of fertilizers and at the same time conserve soil structure is a mighty complicated business."

It seems safe to say that the organic and the mixed sections have proved different means to the same ends—at least for the first rotation and a half, or 15 years. The health of both cow herds was above average; both chicken flocks showed a steady increase in production over the years; the humus content increased in both soils; and crop, milk, and egg yields were respectable on both. Since that time, however, production on the organic section has begun to drop, and production on the mixed section has leveled off.

But agricultural practices, at least in the United States, have changed far beyond what the founders of the Haughley Experiment would have thought possible in 1938. If the Haughley Experiment were starting today, the researchers would have to set up very different conditions. To duplicate modern agricultural practices, they would have to feed commercially raised livestock on crops from the stockless section; then compare their health and productivity with those of the mixed and organic section livestock. Acknowledging that crops like those from the stockless section and animals fed on such crops are our food source today, Chris Sharman at Haughley says that he feels there is a place for artificial fertilizers, used sensibly and in balance with other practices of sound soil management. But they should not constitute the sole means of soil maintenance, as is now so often the case in this country.

Such understanding is the result of long-term, painstaking research. For this reason, experiments like the one at Haughley Farms are vital; only through dispassionate analysis of the effects of different agricultural methods will we be able to understand the relationships among soil, plants, animals, and human nutrition. ■

 by Arthur W. Galston

Peking Man (and Woman) Today

In the last issue, I described a large agricultural commune on the outskirts of Peking. That report benefited from the weeks that my family and I were able to live and work on the commune, sharing with the peasants of our production team not only their labor but also their living quarters, food, beds, water and sanitary facilities, political meetings, and leisure time activities.

In this article, I shall attempt to describe life in the nearby capital city, but in a real sense, this report will be less authentic than the previous one. My view is that of an outsider, a visitor living and eating in a luxury hotel, and being driven in a chauffeured limousine to visit factories, apartment houses, parks, and other points of city life. I did attempt to balance these officially sponsored visits with observations made in unescorted strolls through the streets, visits to department stores, rides on buses, and lounging in the parks, but because of scanty knowledge of the Chinese language, I did not come away with the feeling that I had penetrated to the essence of the city. Nonetheless, these observations are certain to increase the reader's understanding of the people's life in Peking, if only because eyewitness accounts have been so scarce in the United States.

It is important to start with the fact of life in China that almost all women, as well as all men, work. Certainly there are some people, mainly elderly, who are not physically able to carry on with the rigors of a regular job, but such people seemed relatively few in number. Obviously, to make it possible for married women with children to work full time in a factory, it is necessary to organize a comprehensive system of child care, convenient transportation and shopping, and a rationalized system for the performance of household chores, such as cooking and cleaning. This the Chinese seem to have achieved well.

The first trick is to avoid the necessity for much mass transportation by building factories in the midst of established housing for large numbers of workers; we saw, in fact, one new factory being built together with apartment dwellings for its workers. The factory contains nurseries for young children from two months to two and a half years old; after this they can go on to kindergarten until age four and a half, then to higher kindergarten, which prepares them for entry, at age 7, into primary school (through age 12) and middle school (until 16). Such schools are frequently within, or at least close to, the factory-housing complex.

A pregnant woman is put on a light work schedule two months before bearing her child and is given one extra hour of rest per day. She then gets 56 days of maternity leave with pay, and upon her return to work is permitted half an hour during each of her half-day shifts to nurse the baby. Under this system a married woman can bear children and continue to work with minimum complication; when she goes to work at the nearby factory, she leaves her child under the competent supervision of employees paid and trained to do just that job. When her work is over, she takes her child home to a normal home life and influences. We did run into a few factories in which children were left in live-in nurseries for the entire week, but these seemed much less numerous than the day-care type.

While close proximity of the factory to living quarters is the rule, there are certainly many people who do have to travel some distance to work. This is done either on foot, on bicycles (there are said to be

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more than 1½ million in Peking, a city of between 3 and 4 million people), or by public transportation in buses or subway trains. Bus rides cost 1 to 2 cents in U.S. money; the buses run every few minutes and are quite crowded. Despite the congestion, we always got seats when we entered a bus because the politeness of the Chinese will simply not permit a foreign visitor to stand. Most buses are diesel-powered and spew forth noxious fumes, but others are quiet, electrified trolleys, usually consisting of several segments hooked together.

What saves the traffic situation from chaos is the scarcity of vehicular traffic; there are no privately owned cars at all in China, nor is there any plan that there should be. The main component of traffic is thus the forest of bicycles, which occupy about half of each of the right-hand traffic lanes. The buses, trucks, and limousines make their way through this maze by frequent and sometimes indiscriminate use of horns. The result is heavy noise pollution with which the Chinese will someday have to cope. Most travelers on the streets move at a slow, deliberate pace; we saw few traffic accidents or even incidents, and people generally kept their good humor about complications that did develop.

The newer apartment houses for the workers are usually brick structures, four to six stories tall, sometimes with balconies outside one room of the apartment. The apartments themselves are small by our standards; a family of four or five generally lives in an apartment of two rooms plus kitchen, bathroom, and small foyer. Each of the rooms contains beds as well as other furniture and must thus serve a dual function. While these quarters are much less spacious than those on the commune, they are apparently so much better than they were a few years ago that nobody complains much. In fact, many workers live in much older and suboptimal quarters and anticipate the day when they can move into one of the newer blocks with running water, water heaters, flush toilets, and proximity to work, shopping, and other conveniences.

All stores are, of course, owned by the government; they are generally grouped together in shopping districts, as in our own country. We shopped by ourselves in several large department stores, which were extremely well stocked with simple consumers' goods at modest prices, although there were some surprising disparities. A pair of shoes, for example, cost 3 yuans, but so did a pair of nylon socks. We later learned where to buy the cotton socks that cost less than 1 yuan. Since the average salary is about 60 yuans per month, with a range of about 40 to 110 yuans, this may seem like a disproportionate amount for shoes or socks, but most families have at least two wage earners. And when you consider that rent and utilities together generally cost under 5 yuans per month and that medical care and education are virtually free, you can understand why the Chinese city dweller feels pretty well off these days.

Canteens at the factories serve all meals at a cost of about 12 to 15 yuans per month per person; many working families take advantage of this, although others prefer to cook at home, which is cheaper but more trouble. Other typical prices are a dozen eggs .90 yuan, a bar of soap .37 yuan, wine 1 to 4 yuans, cucumbers .38 yuan a pound, radishes .06 yuan a pound, a pound of beef .75 yuan, of mutton .71 yuan, of pork .95 yuan, and of fish .46 yuan. Tea ranges from 3 to 10 yuans per pound, depending on the type. A bicycle of good quality costs about 150 yuans, or about two months salary for a well-off worker.

In evaluating the true meaning of these prices, it is not at all helpful to know that the official exchange rate of about 2.4 yuans to the dollar gives the yuan a nominal value of slightly more than \$.40 in U.S. money. What is important to note is that most Chinese seem to have more than enough money to satisfy their basic needs, and in Peking at least, the stores were full of people looking to spend available money. There is no inflation, no fluctuation in prices (rice has been stable at .18 yuan for a pound ever since liberation in 1949), no sales tax, and no income tax. The government obtains its revenue entirely through the purchase and resale of all items in the economy. While this system must keep a small army of econo-

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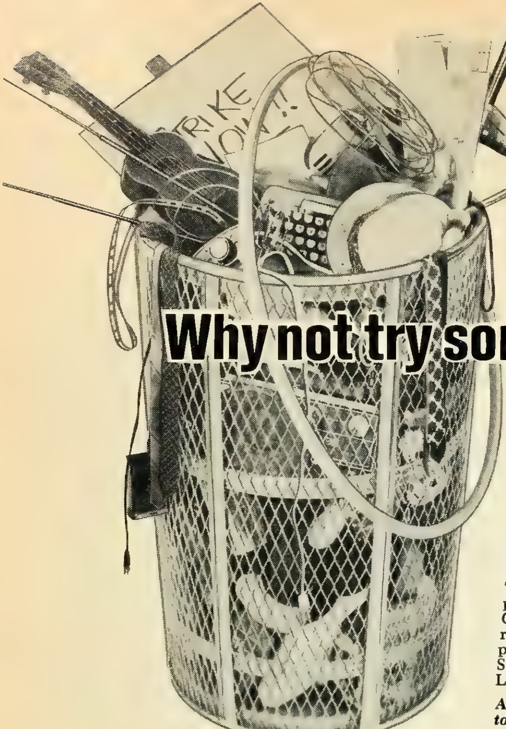

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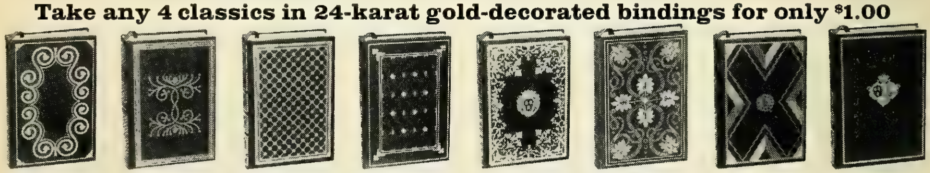

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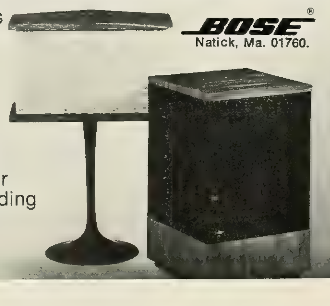


mists busy, it does appear to work.

The factories themselves vary greatly in appearance. The newer ones are models of good planning. They generally consist of moderate-sized buildings about three or four stories tall set amongst greenery and connected by landscaped paths. The working rooms are airy and well lighted, the work proceeds at a busy but not frenetic pace, and the workers seem to be in good spirits, at least to the inexpert eye. Each factory is managed by a Revolutionary Committee consisting (as in the commune) of workers, cadres, and army people elected by the masses. Women are appearing in greater and greater numbers on such governing bodies, although they are still underrepresented. There is compulsory study of the classics of Marxism-Leninism-Maoism, generally for 90-minute periods twice per week. Since the factories and associated workers' apartment houses are frequently surrounded by parks, athletic fields, theaters, schools, and hospitals, many Chinese workers find it unnecessary to ever travel far from their homes.

Let me comment briefly on the appearance of the people, because so many inaccurate remarks about them seem to have created false impressions here. The people are not unfeeling automatons without much emotion; on the contrary, we found them lively and generally zestful. Their most annoying characteristic is probably their tendency to stare at foreigners; at such times, the impassivity of their faces is difficult to interpret, but no overtly unfriendly act marred our visit.

Men and women do dress alike in cotton pants and square-cut jackets, but there is, contrary to accepted notions, some variation in color and style. Some women wear skirts and blouses in flowery patterns, although this is certainly not the rule. I got the impression that clothes in China, as in the United States, partly expressed the personality of the people wearing them, even though the prevailing ethic in China emphasizes a playing down of personal vanity. Some people were obviously dressed very sharply, with well-fitted, well-ironed cotton uniforms, while others had a much more casual and rumpled appearance, as here. Significantly, al-

though we saw some patched and worn work clothing, we never saw a single person whose clothes indicated a loss of self-respect or morale. There are also absolutely no beggars on the streets, a remarkable achievement for any Asian country. Tipping is unknown, and if offered, tips would be refused as a sign of lingering imperialist influence.

One cannot close any discussion of Chinese cities without remarking on their cleanliness, orderliness, and freedom from crime. In Peking, Canton, and Shanghai, we did a great deal of wandering on our own; we were never warned to avoid certain areas, and as I remarked above, were never troubled by untoward incidents. From this we conclude that muggings, robbery, rape, and the like must be rare in Chinese cities, and published statistics certainly support this impression. Drug traffic, prostitution, and gambling have been virtually eliminated, and Western doctors who have worked in China affirm that venereal diseases are completely gone.

The streets are clean and neat partly because the Chinese do not have as much to throw around as we do. But even when they have things to throw, they seem to litter less than we do, although we did see some displays of carelessness with ice cream wrappers, watermelon rinds, and the like. But the cleanliness of the cities can largely be attributed to the large corps of workers who, both by hand and with machines, constantly manicure the cities to keep them attractive. Their ceaseless activities remind us that with sufficient will, support, and labor, even the "impossible" job of keeping urban environments decent can be accomplished.

Thus, the Chinese cities, like the countryside, are full of busy, healthy, well-fed people carrying on their labors with what appears to be good morale and a sense of purpose. Most Westerners would find life in China difficult and terribly circumscribed culturally, but even that may change in a fairly short time. So much has already been accomplished in the years since 1949 that I would hate at this point to sell the Chinese short on anything.

Columnist Arthur W. Galston teaches biology at Yale University.

Eduardo the Healer

His artistry and beneficence were smothered by the economic and social pressures of rural Peru. . . until he became a curandero

by Douglas G. Sharon

When, in 1965, as a member of an archeological expedition in Peru, I first met Eduardo "Chino" Calderon, he was an artist in charge of frieze reconstruction at Chan Chan. This archeological site, located near the modern city of Trujillo, not far from Lima, is the ancient capital of the kingdom of Chimu (A.D. 1000–1440) and the largest adobe ruin in the world. Later I discovered that Eduardo was also a *curandero*, or folk healer, a follower of an ancient but changing cultural tradition now illegal in Peru.

Heavyset and bulging at the waist, Eduardo is dynamic and agile. His round, expressive face is as pliable as the clay he manipulates to restore adobe friezes. He has confidence and a robust sense of humor, which seem to emanate from a deep reservoir of inner strength.

Curanderos are the contemporary counterparts of pre-Columbian religious healers who cured with medicinal plants. In the kingdom of Chimu, these healers, known as *Oquetlupuc*, were greatly respected and well rewarded for their services. If, however, a patient died under treatment, the doctor was often put to death by flogging.

Usually a *curandero* can cure more than physical illness. He is also reputed to be able to locate lost or stolen property, divine future events, assure success in personal matters, romance, and business, cure insanity and alcoholism, and counteract the effects of witchcraft.

Unfortunately, it is often difficult to distinguish between a *curandero* and a *brujo*, or sorcerer, who, while usually able to perform many of the same feats as a *curandero*, is particularly noted for his ability in adverse love magic and witchcraft. Since the Spanish conquest, both *curanderos* and *brujos* have been regularly persecuted by the Church and the law. Although they were forced underground by such persecution, their knowledge has persisted via oral tradition, passed on from *curandero* to apprentice over the centuries. While folk healing has yielded to clerical pressures by adopting many of the trappings of Christianity, much of the ancient shamanistic content has been preserved.

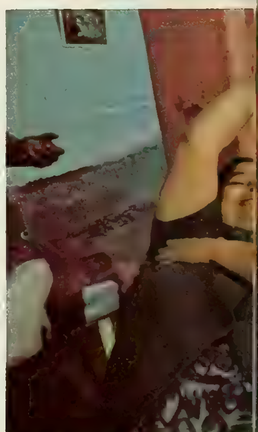
Despite the persecution, there are still many folk healers. Indeed, one small town in the north of Peru recently had one hundred *curanderos*. These practitioners do not simply represent a quaint cultural tradition that is being wiped out by modernization. Rather, *curanderismo* is adapting to cultural change and *curanderos* do not always shy away from modern medicine. Common ailments are often treated by pharmaceutical products, as well as by those medicinal plants used during traditional folk healing sessions.

The adaptability of *curanderismo* is a direct result of the socioeconomic structure of northern Peru, a rigidly stratified society with few opportunities for breaking out of the enduring economic patterns. Folk healing, in addition to curing sickness and disease, also provides a method of psychologically alleviating the strains of living in a society where competition for a livelihood is harsh.

Although he is also a practicing artist, archeologist, and fisherman, Eduardo's interest in *curanderismo* is not a passing one. It has been spurred through many years of interest in, and study of, religion, mysticism, medicine, and the arts, especially ceramics and sculpture. He was born in 1930 in Trujillo to parents of modest means. His father was an artisan competent in many trades, but especially skilled in shoemaking, one of the first trades that Eduardo learned. As the oldest son of the family, Eduardo learned early how to make a living. During grade school he carried produce in the local market and sold chocolates in the theaters of Trujillo. He also worked in the meat section of a market, which eventually led to a job in a slaughterhouse.

At sixteen he began his high school education at a seminary in

To meet the needs of his growing family,
Eduardo supplements his income by fishing.
Yet he finds the time for many
lively social gatherings at his home.



Although he is a *curandero*, Eduardo, opposite page, earns a living mainly by reproducing *huacos*, an ancient Peruvian art form. At left, finished clay pieces are placed in a hole for firing. Gasoline-soaked cow manure is burned to provide heat, below.

Trujillo. Initially he was attracted to the priesthood, but because he found it stifling, his interest shifted to the study of medicine, a goal made impossible by his limited economic resources.

Increasingly disenchanted with his studies, Eduardo finally left the seminary just before completing his fourth year and went to Lima at the age of twenty. There he worked as an assistant bricklayer, a job that earned him enough money to enter Lima's School of Fine Arts. But disillusioned with the teaching system, he left the school before completing the first year. He did, however, continue to make wood sculptures and pottery, holding occasional exhibitions in Trujillo.

On his return from Lima, Eduardo turned to fishing, using the traditional methods of the coastal hamlet near Trujillo where he took up residence. These included the use of nets strung from the shore and hauled by donkeys and the casting of nets from one-man reed boats. At 23 he met the daughter of one of the hamlet's fishermen. They fell in love and have been together ever since. As of 1972 they had nine children.

In the 1950s the fishing industry in Peru was beginning to expand, especially at Chimbote, south of Trujillo. To increase his income for the support of a growing family, Eduardo seasonally migrated to Chimbote during the fishing season. During the off-season he worked as a stevedore loading sugar at Trujillo.

In 1962, when the American hospital ship *Hope* put into port for a year, the staff frequently purchased his ceramics. This gave Eduardo a chance to pursue his art almost full time. When the ship left, Eduardo was offered a contract in the United States to commercialize his talents on a large scale. However, at this time his mother became seriously ill. Since his father had left the family, Eduardo, as the oldest son, felt compelled to stay and look after his brothers and sisters, some of whom were minors. So once again he took up his stevedore's hook and his fishing net.

Eduardo continued working in Salaverry and Chimbote until he had saved enough capital to begin payments on a secondhand boat and net. This allowed him to fish from his own community, where he be-

When not working, Eduardo is perpetually clowning. Along the lonely Peruvian coast, he imaginatively leads his children in play.

In Salala, a town in northern Peru where Eduardo visited another *curandero*, a father brought his disturbed son to a healing session for treatment. Eduardo helped subdue the boy when he became agitated.

gan to introduce modern fishing methods. But in 1965 the Peruvian fishing industry suffered a bad year, forcing small fishermen like Eduardo out of business. Thus, at the age of 35, he was forced to begin again.

Owing to his exhibitions and the interest of the *Hope* staff, Eduardo began to attract attention as an artist of considerable merit. When a local committee organized an archeological restoration program for the nearby ruins of Chan Chan, Eduardo was offered a job.

Throughout these years of hardship, Eduardo was also evolving as a *curandero*. His early interest in the priesthood was an attempt to answer a call to serve humanity. He had dreams urging him to prepare himself and he felt a yearning to help alleviate man's suffering. The priesthood was a disappointment and medicine was out of reach. Neither discipline allowed the full expression of his artistic abilities.

At 22 he had become ill with a strange ailment, which did not yield to medical attention. Both his grandfathers had been *curanderos* in the highlands, so he knew about these practices. As a last resort, his family took him to a folk healer and he was quickly cured. He did not understand what had happened, and his curiosity was stirred. Two years later his uncle, noted for his abilities in working with a *mesa*, or table of folk healing, agreed to apprentice Eduardo. Eventually he gained enough experience to serve as a *rastreador*, one who helps the *curandero* focus his supernatural "vision" on patients' problems.

During one momentous session, the Christ of the *mesa* (embodied in the crucifix) chose him to effect a part of the curing ritual. After that session Eduardo felt that he had outgrown his teacher. Yet he did not feel ready to set up his own *mesa* because *curanderismo* requires a long and difficult apprenticeship. So he went north to work with famous *curanderos* in Chiclayo, Motupe, and Ferrañafe.

When Eduardo returned he was still hesitant to practice on his own. A cousin suddenly became seriously ill, however, and her father, suspecting that she was suffering from witchcraft, implored Eduardo to cure her. Despite his doubts, he decided to try. In two sessions he uncovered the cause and cured her, launching his career as a *curandero* at the age of 28, after four years of training. In gratitude to God, Eduardo made a promise to never abuse his power and to work for humanity.

Today, after fourteen years as a full-fledged *curandero*, Eduardo is still learning and growing. His active mind is constantly probing and seeking new challenges, as evidenced by his extensive reading in theology, philosophy, psychology, art, and the occult. He has even completed a course in nursing from a correspondence school in the United States.

But his erudition only supplements the keen insight into human nature that he has gained from wide experience. He is direct and candid in his dealings with his fellows, and he does not believe in keeping his knowledge a secret. For Eduardo, *curanderismo* is simply a matter of vision, gained by those with a sincere desire to learn and practiced on a regular basis. But it is my belief that *curanderos* are born and not made, that they are unusually gifted and perceptive people. Eduardo is not a common man. He sums up his own philosophy very simply:

> I work under a faith more than anything, a promise that I made when I was initiated as a *curandero*—for one must make a promise, of course—a promise to serve man without thought of gain, whoever he may be, whatever the circumstances.

Eduardo is proud of his abilities. When he discovered my interest in this phase of his life he was willing to discuss it in great detail. His honesty, seriousness, and confidence in his own powers were impressive. But his marvelous sense of humor included the ability to laugh at himself. After our first conversations, he began using what little English he knew in mock seriousness and, in a deep voice he would say, "I am a wizard." Then he would roll his eyes back in his head and pucker up his mouth in feigned awe, followed by a broad smile and a hearty chuckle.

Unfortunately, our group then launched an expedition to the highland jungles east of Trujillo. After one more expedition to another part of Peru, I returned to the United States in 1967, thus ending, I thought, any hope of further research in folk healing.

But in 1970, after winning an anthropological fellowship from the University of California at Los Angeles to study *curanderismo*, I found myself back in Peru, hoping to study folk healing with Eduardo. With his approval to undertake an apprenticeship, I was launched on a series of adventures into the realm of the human psyche. Much of the restoration work at Chan Chan had been discontinued, and Eduardo now had to work full time producing copies of ceramics for tourist shops. This was a boon for me, as I

was able to talk with him in the privacy of his home while he worked on his pots. It was also easier for patients to find and consult him.

For consultations involving business, love, or other advice, Eduardo went into a separate room to perform cartomancy with a deck of Spanish divining cards. For sickness or the suspicion of witchcraft, which often went together, he rubbed the patient down with a live guinea pig, opened its stomach, and performed entrail divination. The sensitive guinea pig is believed to take on the body "humors" and ailments of the patient. In cases of organic disorder, it is thought that the diseased organ becomes spotted or turns black. For ailments caused by witchcraft the spine of the animal is supposed to break. In the latter case a date for a curing session was set. Sessions could also be arranged to overcome love magic or to assure success in a business or romantic venture.

When the guinea pig revealed a serious organic disorder, Eduardo indicated the organ affected and urged the patient to seek medical attention. His diagnosis of organic ailments was facilitated by the medical knowledge gained from his correspondence course in nursing.

One occasion demonstrated Eduardo's balanced use of modern medicine and folk psychotherapy. Early one morning a car drove up to his house and a middle-aged woman, aided by her two sons, emerged. She had spent a sleepless night because of pains in her abdomen; her face was pale and the whites of her eyes had a yellowish cast. She told Eduardo that she thought a neighbor had hexed her after an argument they had had a week earlier.

After checking her symptoms, Eduardo rubbed her with the guinea pig she had brought and made the sign of the cross over her. His wife, Maria, was told to hold a basin under the animal as he quickly sliced the guinea pig down the middle and peeled the skin back to reveal the internal organs and spine. The animal squealed piteously before it lost a torrent of blood—lapped up by the household dogs—and died. After spraying perfume over the lifeless carcass to purify the sacrifice, Eduardo peered carefully into the quivering viscera of the animal. Discovering that the spine was still intact, he meticulously inspected each internal organ. They were all normally colored except the liver, which was black.

Eduardo told the woman that her liver was diseased and that she should seek immediate medical attention. The woman protested that she was sure she had been bewitched by her neighbor, but Eduardo guided her hand along the guinea pig's spinal column to show her that it was not broken, and emphasized that the intact spine was proof that she had not been bewitched.

Not everyone who visited the Calderon residence was a patient. Busy as he was, Eduardo always had time for friends; and if they stayed long enough, someone was usually sent out for a gallon bottle of *chicha,* beer made from fermented corn. There were old fishing cohorts, stevedores, teachers, shopkeepers, students, artists, businessmen, farmers, old people, youngsters, and drifters. It appeared as if the outside world had beaten a path to his door. As I watched his daily interaction I gradually realized that Eduardo's greatest masterpiece was his own life. He molded it with the same deliberateness and dexterity with which he shaped his ceramics.

It became clear that Eduardo's *curandero* lore is the expression of a profound system of abstract thought that rivals orthodox philosophy. For, in addition to embodying traditional beliefs and practices, it is grounded in personal experience. There is a lusty, earthy quality to Eduardo's system, which reflects a direct contact with nature and a realistic perception of the joys and sorrows of the human situation. The rituals he conducts during sessions, as well as the *mesa* itself, are a direct manifestation and application of his philosophy.

The *mesa* symbolizes the duality of the worlds of man and nature, the struggle between good and evil. Thus, it is divided into two major zones (*campos*) with a neutral area between them. The left side of the *mesa,* called the *campo ganadero,* or field of the sly dealer, contains artifacts associated with the forces of evil and black magic, mainly fragments of ceramics and stones from archeological ruins. This zone is governed by Satan, whose negative powers are focused in three staffs placed upright in the ground behind the artifacts. The zone is needed for consultation in cases of witchcraft, adverse love magic, or bad luck, since this is the realm responsible for such evils and therefore capable of revealing their causes.

The right side of the *mesa,* called the *campo justiciero,* or field of the divine justice, contains artifacts related to the forces of good and white magic, mainly saints and instruments used in healing. The zone is governed by Christ, whose positive powers are focused in the crucifix and in eight additional staffs positioned behind the artifacts.

Between the two extremes is the *campo medio,* or middle field, containing artifacts of a neutral nature in which the forces of good and evil are balanced. This zone is governed by Saint Cyprian (a powerful magician who was converted to Christianity), whose natural powers are focused in the serpent staff. This staff is placed behind certain artifacts that are symbolic of forces in nature and in the world of man that can be used for good *or* evil, depending upon the intentions of the

individual involved. This part of the *mesa* is the focal point of Eduardo's vision. Because of its neutral quality, it is considered capable of reflecting a case without distortion.

The artifacts of a *mesa* are not just a random collection of standard objects; they are accumulated throughout the years. Eduardo started his practice with several utensils and a few key artifacts for each *campo*. As his skills improved, he enlarged his collection. Each article has been acquired under special circumstances—as gifts from fellow *curanderos* or patients or after careful search in dry riverbeds, the mountains, or archeological ruins. Many have been made by Eduardo from materials that are of particular significance to him as an artist and fisherman. In addition to its personal meaning, each artifact has its own *cuenta*, or "account," which is activated during a night session. Each artifact is a focal point of a particular force. Collectively, they are a projection of Eduardo's spiritual power, which becomes activated whenever the *mesa* is manipulated in conjunction with the drinking of a psychedelic brew made from the cactus San Pedro. Within the standard symbolic framework that is passed from *curandero* to initiate, there is room for personal elaboration once the initiate gains mastery over the curing art.

In setting up the *mesa*, Eduardo always positions everything so that the sea is behind him. He considers it to be a protective force that prevents him from being overtaken from behind. His personal experiences with the sea have led him to accept the power of this Chimu deity. This is typical of his development as a *curandero:* a painstaking process of incorporating ancient beliefs and practices with modern times and the *curandero*'s personality.

A night healing session enables the *curandero* to focus his vision and manipulate the forces of the *mesa*. There are two parts to the session: ceremony and curing. A typical ceremonial part lasts from about 10:00 P.M. until midnight and consists of a series of prayers, rituals, and songs performed to the rhythmic beat of the *curandero*'s rattle, interspersed by periodic nasal imbibition, called "raising," of a mixture of boiled San Pedro cactus and wild black tobacco juice by all present.

The first part of the ceremony terminates at midnight with the drinking of a cup of pure San Pedro infusion. The purpose of the ceremonial division is to invoke the forces of nature and guardian spirits, to make patients susceptible to therapy, and to focus the *curandero*'s vision on the problems at hand.

The second part of the session, which lasts until about 4:00 A.M., consists of the actual curing acts. Each person present—the *curandero*, two assistants, patients, and patients' friends—must take a turn before the *mesa* while the *curandero* chants a song in his name. Everyone then concentrates on the staffs and swords at the head of the *mesa*. One of these artifacts, the one that is the focal point of the forces affecting the patient, is supposed to vibrate. It is then given to the patient to hold in his left hand while the *curandero* chants the song of the staff to activate its "accounts" and cause it to manifest its powers.

While everyone considers the patient's problem, the *curandero* begins a long divinatory discourse in which he relates what he sees. Sometimes others present see the same things as the *curandero*. The purpose of the discourse is to release from his subconscious whatever blockages are causing the patient's problem. When the discourse ends, the *curandero*'s two assistants both nasally imbibe the tobacco juice and San Pedro mixture in the patient's name. Then, while holding the staff over his head, the patient must nasally imbibe a liquid provided by the *curandero* (usually the tobacco juice and San Pedro mixture, but other liquids, often a perfume, may be chosen. This is called "raising the staff." Finally an assistant or the *curandero* rubs the patient with the staff, sprays it orally with whichever liquid the *curandero* has chosen, and returns it to the head of the *mesa*.

After all present have had a turn before the *mesa*, the *curandero* finishes the session with a closing prayer. Before departing, each person is orally sprayed with a mixture of water, lye, and white corn flour while the *curandero* makes the form of a cross in the ground where the *mesa* stood and sprinkles the four corners of the area and the outlines of the cross with the same white corn flour mixture.

At one session in which Eduardo treated an entire family, the therapeutic manipulation of artifacts and rituals became quite clear. The father's business had been declining, and he was sick and unable to walk. Medical attention had not alleviated his condition. At the same time, his children had been dropping out of school or quitting their jobs. The father was a practical-minded businessman who, until this setback, had been successful. This was his second session with Eduardo. Although he was beginning to walk again, he was skeptical about being healed, as he did not believe in witchcraft or folk healing and had decided to consult Eduardo only after much urging on the part of a business associate.

The atmosphere was charged with tension. As each member of the family took his turn before the *mesa* and Eduardo divined about people and events from their lives, their amazement was obvious. Each person had difficulty raising the staff after the divination, a sign that

the forces responsible for the witchcraft are resisting therapy.

At one point a screech owl flew overhead, letting out an eerie cry and wracking the family's nerves. Since owls are associated with black magic and sorcery, they are considered to be bad omens. Then the hood of a small truck in the yard where the session was held buckled, as if someone had put pressure on the metal and then let it go. We had a feeling of foreboding.

At this point a daughter of the family took her turn before the *mesa*. When divining, Eduardo had warned her about certain envious friends who wished her ill. Everything proceeded normally until she tried to raise the staff. She tried and tried. After coughing and sputtering, she regurgitated the brew. Then she began to lean crazily backward. Someone exclaimed that a monster was pulling the girl's hair from behind in an effort to carry her away. Suddenly, Eduardo raised a liquid in the name of the girl, grabbed one of the swords at the head of the *mesa*, and charged into the open behind her. Before I knew it, he was conducting a furious sword battle, slicing and slashing like a buccaneer. With incredible dexterity and grace, he suddenly flipped into seven successive rapid-fire somersaults, holding the sword over his head with the blade outward at the beginning of each. The direction of his movements over the ground formed a cross.

Catching his breath, he resumed the curing routine, passing on to the next ritual as if nothing had happened. The tension was broken. From then on, everything progressed smoothly. After the session the girl asked Eduardo what had happened to her. He was the essence of matter-of-fact self-confidence and paternalism. He told her that she had confronted forces with which she was unfamiliar, but, like everything else in life, they could be dealt with once one makes an effort to understand their function. Later when I asked him what had happened, he informed me that the sorcerer responsible for the family's ill fortune had attacked the session, making emergency action necessary. The sword battle and somersaults were intended to shock the sorcerer and break his spell.

There was one more session with this family before I returned to the United States. It went smoothly, with no tension, and everyone was able to raise the staff. When I left Peru, the father was better and his business and the family were getting back to normal.

Scholars have theorized that ailments such as these often have social explanations. Even when social conflicts are not apparent, *curanderos* try to seek out any such conflicts in their patients' backgrounds as a method of accounting for the illness. The cause of the businessman's ailment, for example, turned out to be a hex placed on him by an envious competitor who had gone to a sorcerer when the victim took away some of his business.

In the mountains near the border of Ecuador lie a series of sacred lakes visited by pilgrims led by *curanderos*. Upon arriving at the lakes, the pilgrims nasally imbibe an herbal brew. After a ritual bath, they warm up by jumping, rolling, and running.

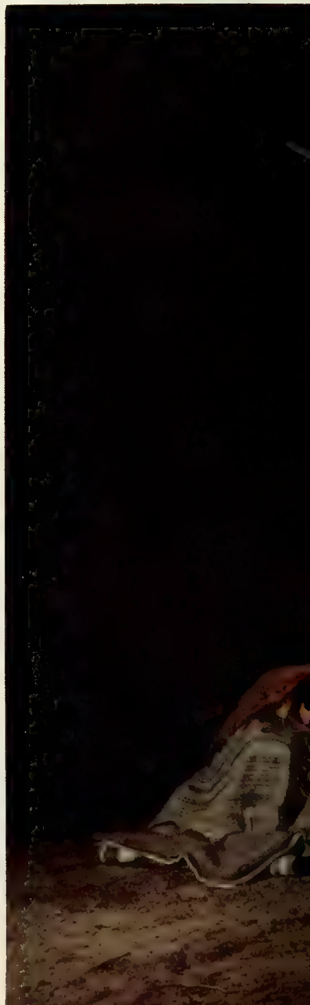
Social conditions in northern Peru explain much of the population's attraction to witchcraft. The region suffers from an imbalance of service industries based upon a limited industrial base of sugar, cotton, and fishing industries. A high unemployment rate has grown out of the region's rapid population growth and heavy urban migration. The result is a rigid social stratification with little upward mobility, chronic insecurity, and extreme competition for jobs. Such conditions produce great frustration and interpersonal conflict, leading to a high level of aggression that is not directly expressed. This aggression, however, finds expression in a projective mechanism, an "envy syndrome," that is highly supportive of a continued belief in witchcraft.

It invariably crops up in cases of witchcraft treated by *curanderos*. For example, if someone is envious of another person, he can seek out a sorcerer to help him express his covert aggressions. Or if one suffers illness or personal tragedy, he can blame it on the envy of an enemy—real or imagined—and seek alleviation from a folk healer. By the same token, guilt or fear resulting from a violation of norms geared to support the rigid social structure can be blamed on the malice of an envious enemy, whose actions can only be counteracted by a *curandero*. Thus, witchcraft serves as an escape valve, permitting aggression to express itself without attacking fundamental institutions. As long as current social conditions prevail, the *curandero* will continue to play an important role in northern Peruvian society.

Although supernatural forces are often blamed for the patient's ailment, therapy usually consists of discovering disturbed social relationships, a procedure that rids the patient of his pathological symptoms. In this way *curanderismo* provides individuals with channels for anxiety reduction and treatment. By following a prescribed pattern of stereotyped folk diagnosis and culturally determined ritual, the *curandero*, who receives a nominal payment of money, *chicha*, or favors, is able to relieve the symptoms and reintegrate the patient into society.

Although Eduardo is a tradi-

Knowledge of herbal remedies, one of which Eduardo is preparing, below, is part of a *curandero*'s art. The remedies are sometimes sprayed on the artifacts of the *mesa*, which is being set up, right, by Eduardo and his wife. During one healing session, below right, Eduardo fights off a sorcerer's spell that was interrupting the session.



tional *curandero,* who depends on his ability to communicate with spirits in order to heal, his use of modern pharmaceutical products and medical practices indicates his willingness to adapt to cultural change. His nursing studies are a strong affirmation of his acceptance of modern medical practices, a form of technological innovation that he does not see as threatening his traditional practices.

When he encounters a natural illness that he cannot heal, such as an organic ailment or a chronic disorder, Eduardo informs his patient and recommends medical attention. This became apparent at one session I attended when Eduardo diagnosed ten cases in one night. There was only one case that he considered to be caused by witchcraft. For the others, he advocated diets, herbs, and medical attention.

Despite this adaptation, Eduardo maintains a firm conviction that his services are essential. This is probably the case in his community, which does not have a doctor and where many are too poor to afford medical attention, even if it were available. But this does not explain Eduardo's large number of patients who come from Trujillo, Lima, and other parts of the country. The great majority of these patients are middle-class Peruvians with modern medical benefits available to them. Some have already been to a doctor and have found no relief, or wish to supplement the medical therapy, while others suspect they are suffering from witchcraft.

Despite the increasing influence of modern medicine, the *curandero* has not been superseded or rendered obsolete in northern Peru. If anything, his role in Peruvian culture is meaningful and useful during a stressful time of rapid culture change and development.

Craftsmen of Necessity

Because they cannot afford to be wasteful, woodworkers in some cultures create beautiful and lasting ties with their environment

by Christopher Williams

The one factor that differentiates man from all other organisms is his need to alter his environment to a greater degree than any other creature. He must do so because he is essentially alien to almost every environment. Most are too hot or cold, too wet or dry. Man cannot find food to eat, water to drink, or a place to sleep, so he must plow and plant, dig and build.

Every organism will change its environment to some degree; its mere existence within that environment alters it. It eats and converts foodstuffs, it consumes energy, it dies and leaves its body. Many organisms are home builders, and sometimes their homes are also their food. Trees are felled, rivers diverted, grasslands destroyed, and islands created. But none alters so drastically as man.

Most other creatures have been working their environment in the same way for millions and billions of generations, and the environment has come to accept their ways. It has changed over these years to accommodate their work and to even expect their alterations. Organisms become their environment, and if they were to be eliminated, their environment would undergo crucial reorganization. Man has not become his environment, and rarely has the environment accepted him. Most of man's drastic actions have come within the last two hundred years—a microsecond in evolutionary terms. His activities expand at an increasing rate.

Long years of weathering emphasize the grain of an Austrian spiked door.

Possibly our natural environment will eventually come to accept us as we are. It would certainly require many thousands of generations, and just as certainly, the environment would be something other than that which we now know. Yet it would be a strange world that would need man's vulgar emissions and hungry consumptions. Just as likely, man could be the germ of destruction that the environment could never assimilate, and his work would lead to the total collapse of the biosphere and, of course, of man himself.

The few human societies that are apparently tolerated by their environment survive because they tread lightly. They do so, not because they want to, but because they must. Indigenous human societies seek and find methods of working that do not violate their surroundings because they lack the power to violate. They use self-regulating systems because they have neither the force nor the material to squander. They compromise because they must.

There is a lyrical decree in the art of building, an edict, an understanding available to those who build with a sensitive hand. It may be a method of using material, a form and appearance, the establishing of an organic system. Or it may be just a light touch or the way the parts combine to make a whole—building by form and fit. Indigenous architects have found this approach through need. They are not consciously aware of the subtleties of their work; they act naturally and out of simple necessity.

Rural people of eastern Europe have maintained stable societies. They expect that family property will remain with the family through many generations. A house is built to last for son, grandson, and his progeny; it is built to remain substantial through hundreds of years. Few houses are built, but each becomes a landmark, a permanent attachment to the ground. To achieve this longevity, the housebuilder thinks in solid terms.

Walls are built of ponderous timbers, notched and mortised together. With weather change, these massive beams move on their joints, expanding with humidity and contracting when the weather turns dry. To permit this movement, the joints are pinned with wood instead of with iron. These pegs not only permit the joints to flex, but also allow the timbers to change without being torn apart. The wooden pin, forced into the hole, is keyed with a wedge to hold it in place.

Over the timbered wall, sapling branches, split in half, are tacked. Over this, plaster is worked on the inside and clay or shingle on the outside. The result is almost twelve inches of solid insulation.

Builders know that wood will sag and lose some of its rigidity over a long period of time, that it will warp and check. So they build to accommodate and outlast these changes. They know that a fifty-foot long, ten-inch-square oak beam will settle eight inches in a hundred and fifty years, so they set an angular stanchion to take hold when the time comes.

Some of these structures in the low country near the Danube River are made completely of hardwood planks more than three feet wide and five inches thick. This timbering is so massive that a house, with the exception of the shingle roof, can be built with a small number of planks.

Over the house broods a great deep roof. Its peak projects to the treetops, and its eaves reach almost to the ground. Under its ponderous ribs, near the long, slanted peak, children are sent up three stories between joists and rafters to sleep

In northeastern Rumania, a gate, counterbalanced so that it swings open easily, is cut from the crotch of a sycamore tree. At right, the roof of an ancient Carpathian Mountain house is built without a chimney; smoke, exhausted from the fireplace, sifts through the thatch and prevents decay.

in the loft in warm protection on winter nights.

Through the years an intimate association is built up between the family and the house, each reflecting the other's personality. The family maintains and patronizes the old house, while the house protects the family.

The roof is usually the first part of a house to wear out, for it receives the brunt of the weather's blow. To enhance the runoff of water, some indigenous builders in Scandinavia use split logs placed vertically, which last almost as long as the building. Others lay down birch bark, over which they line up long, thin logs to hold it down. When overlapped, birch bark is weathertight and almost completely resistant to rot. Perhaps the most enduring is the stone roof. If leaks are prevented, the roof will stay intact until the timbers beneath fall in decay.

Even before the builder puts away his hammer, the destructive forces of nature start decomposing his newly completed structure: the wind erodes, the sun dries, the rain leaches and washes, the insects and animals, organisms of decay, eat at it. The fragile things the builder makes must be sheltered, continually maintained, or just left to lead their short lives. The enduring structures contain material that resists these forces or have so much bulk that a great quantity of natural force is required to consume them.

But the use of an organic system, working with the forces, is the most satisfactory way of controlling them. Less work is required to build, little maintenance is necessary, and a satisfaction is achieved with the creation of a self-regulating system, a living system. At these times, the builder treats his house as an organism that he brings to life and then, by its own mechanisms of self-renewal, allows to sustain itself. The establishment of a self-regulating system is that act of turning anything back on itself to control its own action.

For years the Norwegians have used the organic roofed house. When the house is first constructed, birch bark is laid as a sealer. Then squares of pasture dirt, about five inches thick, along with roots and grass, are laid over the bark. As the seasons pass, the mat perpetuates itself, root intertwines root, and the roof becomes a solid whole. Rain and weather only strengthen it. In winter the dead stalks of grass hold the snow for effective insulation. The spring rains beat the grasses down to shed the excess water, then bring the roof to life again. In summer the grasses grow long and effectively reflect the sun's heat. As the years pass, the roof renews itself from season to season, needing little or no maintenance. Visually, the house blends into the forests and pastures, becoming part of its environment. Yet when the house was

built, its visual effect was secondary.

Sometimes the same approach is taken by masons. They lay stone walls with mud or clay instead of with inorganic mortar. The clay provides a footing for vines. If coaxed to grow in the right direction, when the vines reach maturity they form a solid structure that holds the stone in place and is tight enough to resist the weather.

Houses with deep, pointed roofs of straw also perform as organic units in the forests of Rumania. Although they do not grow, they are, in a sense, alive and maintaining themselves. In an expression of thrift, most houses are built without chimneys, which would let out smoke, thereby wasting it. Stoves and fireplaces exhaust the smoke into the underside of the roof. The smoke fills the rafters, then drifts down to the ceiling of the living floor and slowly filters out through the thatch. This not only acts as central heating, but also cures meat, which is hung in the peak. At the same time, it preserves the straw by checking rot and decay. The act of living in the house preserves it.

If the thatched roof is left unattended for a generation or two, the straw will begin to rot. But if the climate and prevailing conditions are favorable, it will begin to come to life again, re-establishing itself. The decayed and moist straw builds up a rich growing base suitable for mosses; as the straw gives way, the mosses spread, soon encompassing

Harmony between man and his environment is seen in the self-perpetuating sod on the birch bark roof of a Norwegian house.

the whole roof. With a steep pitch the moisture is held out and the roof is virtually self-perpetuating.

The people that build their houses on the rock ledges that jut through the forest in the Transylvanian Alps in the northwest of Rumania have used the elements of the wood's structure to accommodate the climate. They live between the boreal north wind, which cascades down from the Russian plains in winter, and the hot winds off the Yugoslavian plateau in summer. The winter winds are heavy with moisture; the summer winds, very dry. The builders cover their roofs, and sometimes their whole house, with shingles cut from a fir tree that grows in this area. This wood is extremely sensitive to humidity changes, expanding rapidly in moisture and contracting in arid air. The shingles are notched and grooved to mate with one another. In winter, when the moist winds press down on them, the shingles turn dark and become fat with water. Row on row they grow fast together; the more the wind torments, the more solid they become. The house shuts itself in for the winter, secure against the damp. As the winter lets up and the north wind stops, spring introduces the drying wind from the south. By early summer, the shingles turn a lighter gray and ease their shoulder to shoulder press. August opens up the house. The dry shingles move aside for the cool air to run through the house and relieve its inhabitants from the summer heat.

The woodworker is a solitary man, alone with his hands. Beside him, ready for their turn, lie his tools—long-bladed knives to cut long, thin wafers of wood, hatchets and adzes to cut chunks, curved shank gouges to cut spirals. By following the edges and flats of his tools with his thumb and eye, the woodcutter can determine the character of the finished piece. His tools lie before him like a vocabulary, each one possessing a subtle inflection of meaning. With this language of tools and the motions by which he uses them, a conversation is initiated between worker and material. The wood argues in knots and agrees in smooth grain. There is a simple ratio of one woodworker, one piece of wood, and one result. No written plans are needed, nothing on paper, no communication with images, no concern with passing information from worker to worker. The woodworker's plans ride in his mind, intricate or simple as the moment demands. They are liquid, flowing into any development that may appear with the work. The direction of his work rests in his hands and mind; they form an empirical knowledge of what is to be done. As the plan is executed, change and invention are easily accommodated. His products, although preconceived, are spontaneous and varied. Each is fresh and vital, as though it were the only one ever to exist.

A woodworker in a diverse forest finds a pleasing selection before him when setting off on a job. By his selection, he can control and regulate strength, weight, and structure. He may choose as many as five different kinds of wood for one chair: black walnut for the rockers because the nap on its surface will keep the wood from sliding on the floor; powerful ash for the legs; hard, deep-grained cherry for the seat; strong and flexible hickory for the back and arms; and tough birch dowels and wedges to peg and key the whole chair together.

A tree varies from year to year as the climate changes and the forest conditions alter around it. Some years the growth is thick and generous and soft to the chisel. The difficult years add thin rings of hard, dense wood.

From the first cutting to the final stages of aged decay, wood retains its appeal. Sapwood, the growing layer, has a fresh delight in its heavy, moist grain, fat with resin. When the wood is cut and the sap dries, the wood becomes light, workable, and warm to the touch. This is the time when woodworkers take greatest pleasure in working their material. As time passes, wood

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THE ROYAL VIKING LINE WORLD CRUISE CALENDAR

			Vol.
1972	OCT. 21	CARIBBEAN/MEXICO/TRANS-CANAL—20 DAYS	II
	NOV. 10	WEST COAST/CARIBBEAN—32 DAYS	II
	DEC. 19	MEXICO HOLIDAY—15 DAYS	II
1973	JAN. 2	SOUTH SEAS—46 DAYS	III
	FEB. 18	CIRCLE PACIFIC—66 DAYS	III
	APR. 29	W. CST./CARIBBEAN/EUROPE—35 DAYS	I, II
	APR. 29	CARIBBEAN/MEXICO/TRANS-CANAL—16 DAYS	II
	MAY 16	SUNNY EUROPEAN—19 DAYS	I
	JUNE 30	NORTH CAPE/SPITSBERGEN—14 DAYS	I
	JULY 6	NORTH CAPE/SPITSBERGEN—14 DAYS	I
	JULY 14	NORTH CAPE/SPITSBERGEN—14 DAYS	I
	JULY 14	NORTH CAPE-RUSSIA/EUROPE—28 DAYS	I
	JULY 20	NORTH CAPE/SPITSBERGEN—14 DAYS	I
	JULY 28	RUSSIA/EUROPE—14 DAYS	I
	AUG. 3	NORTH CAPE/SPITSBERGEN—14 DAYS	I
	AUG. 3	NORTH CAPE-RUSSIA/EUROPE—36 DAYS	I
	AUG. 12	MEDITERRANEAN—22 DAYS	I
	AUG.18	RUSSIA/EUROPE—22 DAYS	I
	SEP. 2	TRANSATLANTIC—7 DAYS	I
	SEP. 4	MEDITERRANEAN—30 DAYS	I
	SEP. 9	NEW ENGLAND/INDIAN SUMMER—7 DAYS	II
	SEP. 16	NEW ENGLAND/INDIAN SUMMER—7 DAYS	II
	SEP. 24	SOUTH SEAS—67 DAYS	III
	SEP. 24	CARIBBEAN/MEXICO/TRANS-CANAL—20 DAYS	II
	SEP. 27	TRANSATLANTIC—7 DAYS	I
	OCT. 5	NEW ENGLAND/INDIAN SUMMER—7 DAYS	II
	OCT. 12	NEW ENGLAND/INDIAN SUMMER—7 DAYS	II
	OCT. 14	SOUTH SEAS—47 DAYS	III
	OCT. 20	SOUTH AMERICA/SOUTH AFRICA—54 DAYS	III
	DEC. 1	WEST COAST/CARIBBEAN—32 DAYS	II
	DEC. 2	ATL. ISLANDS/AFRICAN COAST—14 DAYS	I
	DEC. 14	SOUTH SEAS—66 DAYS	III
	DEC. 14	CARIBBEAN/MEXICO/TRANS-CANAL—19 DAYS	II
	DEC. 17	ATL. ISLANDS/AFRICAN COAST—16 DAYS	I
1974	JAN. 2	SOUTH SEAS—47 DAYS	III
	JAN. 5	MEXICO—15 DAYS	II
	JAN. 7	TRANSATLANTIC—9 DAYS	II
	JAN. 7	ENGLAND/CARIBBEAN/MEXICO—28 DAYS	I
	JAN. 7	ENGLAND/SOUTH SEAS—75 DAYS	I
	JAN. 16	CARIBBEAN/MEXICO/TRANS-CANAL—19 DAYS	II
	JAN. 16	SOUTH SEAS—66 DAYS	III
	JAN. 22	AROUND THE WORLD—97 DAYS	III, IV
	JAN. 22	CARIBBEAN/MEXICO/TRANS-CANAL—12 DAYS	II
	FEB. 4	SOUTH SEAS—47 DAYS	III
	FEB. 5	AROUND THE WORLD—100 DAYS	III, IV
	FEB. 20	CIRCLE PACIFIC—69 DAYS	III
	MAR. 27	CIRCLE PACIFIC—68 DAYS	III
	APR. 29	CARIBBEAN/MEXICO/TRANS-CANAL—16 DAYS	II
	APR. 29	W. CST./CARIBBEAN/EUROPE—35 DAYS	I, II
	MAY 16	SUNNY EUROPEAN—19 DAYS	I

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Ships of Norwegian registry. And spirit.

The natural fork branch, which has served man for thousands of years, has a stronger intersection than a man-made one. A third tine is added for pitching hay.

accepts the promise of old age with dignity. It becomes dark, oily, and smooth when used by years of hands. It turns craggy and bold in the weather's careless handling. When ancient, it develops the intricate and complicated patterns of decay. Wood is perhaps the material closest to man's own temperament. It is infinite in its variety, vital and filled with imperfections. Each species, each tree, limb, and trunk is an individual and should be so treated. The woodworker adjusts his pace to this individual, at times asserting his strength, at other times following the needs of his materials. He deals with wood as a father controls an independent son.

When wood is used to a point near the limits of its endurance, it can no longer be considered just a volume of material. The grain and the way the grain is placed in the tree to resist gravity become relevant to the woodworker. When wood is cut by woodworkers to build a boat, events that molded the growth of the tree determine the cut of the wood and the structure of the boat.

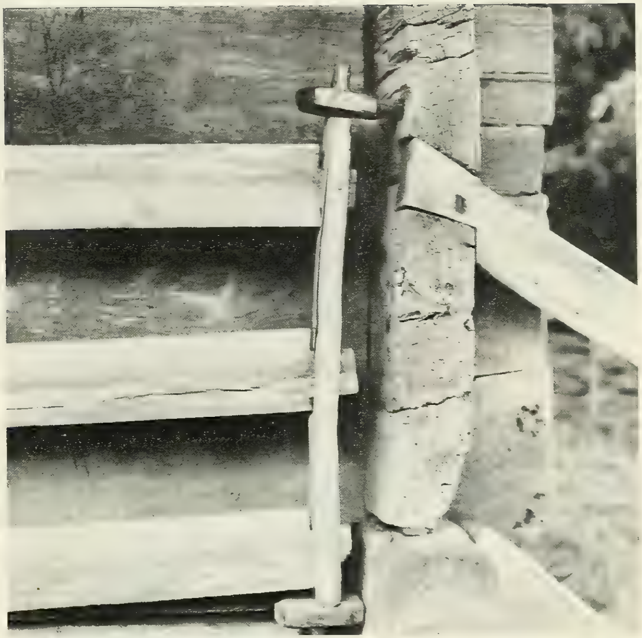
As the powers of natural selection winnow away the unnecessary and clarify a species to its role, the expediencies of need alter and shape the evolution of boats. The unnecessary is trimmed away and the unworthy altered. In different climates and waters, different species emerge to fill their roles. On the still lakes of Scandinavia a species of rowboat has grown to satisfy a need. It is made of large, thin sheets of yellow pine. Fragile, light, and graceful, it slips easily over the water or moves from lake to lake on one man's back.

On the Atlantic coast of Morocco, fishermen have developed a fat-bellied coracle. It is stable, wide, and very heavy so it can break the ocean waves. Its weight and width hold it into the surf when heading out; when returning, its high-swept stern keeps it clear of the incoming waves.

But more than water and use define the builder's work. Perhaps nowhere are the woodworker's abilities more at task than in the exacting art of shipbuilding. Every piece of wood, every form, every intersection must be justified. In the prow, strength must be built up without too much weight. The grain must lie so as to resist shear from both sides; every intersection is a different angle; curve compounds curve. Space must be left for expansion, then contraction. The wood needs room to move; it must be given space to settle but the water must be kept out. At completion the craft must be a moving, working whole, more than the sum of its parts.

As the grain of a standing tree deflects the crush of the tree's weight, the organic boatbuilder uses the wood to structure his boat; it is a harmony of line and stress. The grain follows the outside planking from stem to stern. The boards are cut from tall, straight trees. Inside the hull, the forces press in from the sides, ribs throw their weight laterally. Here, the grain must be curved to turn its back into the work. This requires trunks and limbs that twist and bend as they grow, so that they will hold firm in these obtuse positions.

The tough little seiners of the Egyptian fishing fleet are built with this kind of structure. The trees are selected with great attention to their shape; limbs are cut with the crotch left intact to form the deep angle of the prow when ripsawed into planks. The grain will follow the U's and V's of the hull. Each section of trunk is carefully considered for placement in the framework of the boat. Then it is crosscut



Outside a Rumanian house, notched wall planks serve as supports for a gate and also as a bannister.

into lengths, and the sections are cleaned of bark and smoothed.

Lofting the cuts for each plank is a job reserved for those with years of experience. This work will determine the eventual shape of the boat. With immense patience the lofter judges each log, its grain and thickness, the width, the knots, the bend, and where it will fit into the form of the boat. He marks his decisions with chalk lines. The cut and lofted lengths of trunk then go to the two-man ripsaw. Following the chalk lines and curve, the men cut the trunk into planks. From the center comes a long rib for midship; the sides of the log yield shorter braces and stanchions. Their saw follows the grain through trunk, crotch, and limb. The undulating planking is stacked to await its use and the ribs are squared and lined up in order. This is the unassembled boat. The finished product is a collaboration between tree and builder.

The indigenous builder not only works with the shape of the tree, but also finds advantage in doing so: in the limbs of the tree rest his finely fashioned and stoutly assembled needs. His own workmanship would find difficulty in equaling the tree's shape and durability.

The totally simple expedient of cutting a forked branch to hold two wet boots above the fire is the sublime manifestation of a complex set of rules and values. While these rules are unspoken among the indigenous societies, they are completely understood. The rules are born of logic and find their home in economy and conservation, the conservation of energy and material and the recapturing of effort spent.

From seedling to sapling to maturity, a tree opens its mantle; its powers of growth come from the sun, soil, and air. Its limbs spread and grow heavy. Its great energies are spent and directed toward its own ends. Its shape reflects its individuality, evolution, and environment. Then the tree is felled. When the limb is cut, not only are its cells and fiber captured for reuse, but also the way in which it grew. None of its effort is wasted. The forked branch suited the tree and now suits the use of the man.

A farmer in the east of Finland will walk the soft floor of a spruce and birch forest for his material. Soon, growing above his head, he will find in the limbs of a stout birch the form of his scythe handle. The gentle bend of rise and fall will be cut from the branch and taken home. The bark will be stripped and the unwanted material planed away. Then with his knife the farmer will carefully work into the curve, altering it, shaping it, flattening it to embrace his shoulder and movement as the other end works the grass. Each scythe he makes is an improvement over the last. As he grows older, the shape of each scythe handle corresponds to his changing arm movements. While carving, he swings the new and old scythe in mock cutting to feel where the placement of curve and hold should be for his frame and the grass. The handgrip is placed, the length is altered, and the cutting blade and angle are determined. When the scythe is finished and in use, the man will take pleasure in it, and yet he will consider how it could still be improved. The scythe is molded from the tree, the man, and the grass. The shape is exact.

These people have formed elaborate ties with their environment and materials. Their lives are remote but not meaningless to us. It is not what they build, but their thinking that should be reinterpreted in our

Curved logs are carefully selected to form the configuration of a boat. Egyptian boatbuilders cut beams that follow the log's grain, thus providing maximum strength.

society to control a technology that uses no discipline.

It may be possible for man to live within the biological fabric and leave it suitable for other life forms. But for him to do so, he must have regard for a conservation and economy that technology has taught him to disregard. It is easy to canonize these indigenous societies, but it should be remembered that we would have to become more sophisticated than they to follow their ways. For they, like us, are acting only out of expediency; they must conserve and work within their environment to survive. Our expediencies are consumption, force, and waste. If we were to follow their example, we would be in the unprecedented position of being able to coexist with almost any physical environment, the control coming from within instead of from the outside.

Technical manipulation alone is not the solution. It is the result, not the cause. Before modern technology can become compassionate, modern man must.

The Supersensitivity of Fishes

Because aquatic animals evolved in a very stable milieu, they are especially vulnerable to environmental change

by James W. Atz

Of the 20,000 or more species of fishes alive today, fewer than a thousand have ever been kept in captivity. Of these, only a handful have been domesticated, that is, bred generation after generation in aquariums, hatcheries, or ponds. Despite their economic importance (fish are the chief source of vital animal protein in the diet of more than a billion people) and esthetic appeal (maintaining a home aquarium has become America's third most popular hobby), the keeping of fish has remained more of an art than a science. Possession of a "wet thumb" is still the most important attribute for any fish keeper, be he professional fish culturist or pet fish fancier.

Why do tyros find cats or canaries so much easier to keep at home than guppies or goldfish? And why is it that highly trained scientists hardly do any better? Many hundreds of laboratories all over the world regularly breed white rats, pigeons, and fruit flies (or other species of mammals, birds, and insects) for experimentation, but far less than a hundred scientific institutions breed fishes.

The basic reason is the extraordinary but generally unrecognized sensitivity of fishes. Because they are cold-blooded and, from our viewpoint, silent and undemonstrative, we tend to think of fishes as insensate automatons. The "fishy eye" has become a symbol of coldly calculating appraisal or even of utter indifference. Moreover, all the scientific evidence indicates that fishes are not conscious creatures, as we know consciousness. But insensible though they may be, fishes are far from insensitive.

Scientists themselves have only recently become fully aware of how delicately attuned to its environment a fish really is. For example, in one experiment, when goldfish that were well adjusted to life in an aquarium were carefully placed in another aquarium, similar in all respects to the one in which they had been living, it took four days for the level of glucose in their blood to return to normal. Yet goldfish have earned the reputation of being the hardiest and most docile of pet fishes. Fanciers have found, in another example of fish sensitivity, that a long chase with a net after a particular fish in an aquarium often results in the fish's death, even though it has suffered no physical injury.

Fishes are extraordinarily sensitive to chemicals in the water around them. Only two parts of copper dissolved in a hundred million parts of water can kill some fishes within twenty-four hours, and concentrations of less than one part per *billion* of such pesticides as Endrin are similarly lethal. This is one drop in about 16,000 gallons. As far as their water supply is concerned, fishes are much more delicate than man. Tap water that is perfectly fit for humans to drink may prove deadly in an aquarium.

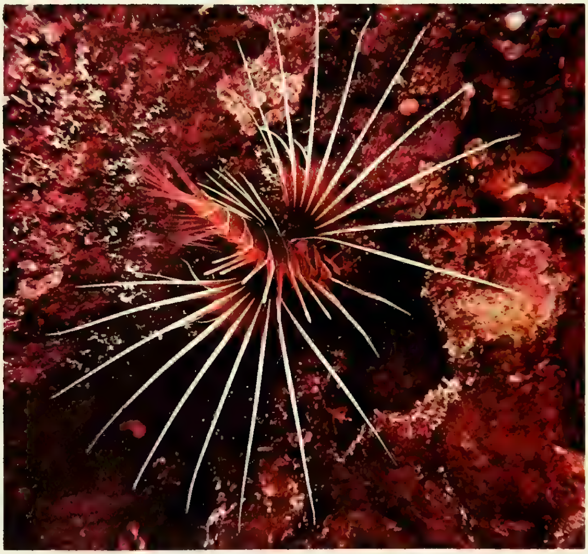
Small amounts of natural substances, such as their own waste products, can also be toxic to fishes. Ammonia is their major excretion, but fish culturists have found that trout kept in water with as little as six parts per billion of ammonia showed abnormal gills. Even such fishes as carp and goldfish, which are much less sensitive to ammonia, should not be exposed for long to concentrations of more than one part of ammonia in ten million parts of water. This is equivalent to putting one drop of ammonia into a 150-gallon tank.

Blackcap basslet

Glass
catfish

Harlequin
tusk wrasse

Whitefin
lionfish



Deathmask
scorpionfish

Red Sea butterflyfish

Physical factors, such as light and heat, also impinge decisively on fishes. Although goldfish can survive comfortably in water as cold as 50 degrees Fahrenheit and as warm as 70 degrees, they are greatly stressed by a sudden change of more than a couple of degrees. If the change occurs too rapidly, a goldfish will die, even though the final temperature attained is well below its upper lethal temperature or above its lower limit. In fact, fishes characteristically show a limited ability to adjust to any kind of rapid environmental change, and the aquarium keeper must constantly guard against all kinds of sudden changes. For instance, a seemingly harmless act like switching on the aquarium light in a completely dark room may cause fish to dash into the walls of the tank and even kill them.

Although fishes are in some ways less demanding and easier to keep as pets than birds or mammals (they don't have to be walked or fed every day), they have certain rather rigid requirements, and if the bounds of these are overstepped, the fishes simply die. In truth, fishes are much more sensitive to their surroundings than, say, dogs or pigeons and are much less able to adapt to any change, particularly if it is a sudden one. The reason for this fundamental difference in the relationship of a fish to its environment and that of the four-footed or winged animal to its is that the fish is an aquatic animal.

Aquatic animals live much more intimately with their environment than do terrestrial ones. Anything suspended or dissolved in the water comes into extremely close contact with fish, mostly through their gills, and there is little they can do to keep harmful substances from entering their bloodstreams or bodies. Because a fish needs a large gill surface to obtain enough oxygen from the water, its gills may have a surface area ten to sixty times as large as the surface of the rest of its body. Practically anything that is in water can easily pass through its gills into its blood. Indeed, the water surrounding a fish can almost be thought of as an extension of the fish's own body, and in this sense all the animals and plants in an aquarium (or lake or even the ocean) are in a close biochemical relationship with one another.

Terrestrial animals show no such intimacy with their environment, and this is the basic difference between life on land and life in water. Life originated in the sea, and without water there can be no life. Every animal (and plant as well) is "wet"—that is, all living things are juicy to a greater or lesser extent. Dry out a plant or animal and it dies; only dormant spores or seeds are able to exist in a dried-out state.

Aquatic animals, of course, face no problem of desiccation, but terrestrial ones do. In fact, the most serious problem for the first land animals, when they started to evolve and come out on land, was to keep from drying out. Insects eventually acquired a hard, impervious cuticle, and reptiles developed a scaly, impervious skin. During their long evolution, aquatic plants and animals have never left their hospitable, wet environment, and consequently they have never had much need to isolate themselves from it.

In contrast, terrestrial animals and plants live in a hostile, desiccating environment. Land animals must keep the deadly dry air away from all their vital organs and membranes except those parts that must come into contact with the air in order to function: the lungs, eyes, ears, nose, and mouth.

Because terrestrial animals had to become protected from an environment that constantly threatened to dry up their vital juices, evolution toward greater and greater independence from the environment was inevitable. For example, animals that could withstand more and more rigorous climates evolved. Warm-blooded mammals and birds, with their hair and feathers, and insects, with their all-covering protective cuticle, eventually dominated the earth.

We see that fateful turn of evolution manifested every time a would-be pet owner brings home a puppy or a goldfish. For every goldfish that survives, at least a hundred puppies make the grade.

And we should realize that the lessons of the aquarium have broader implications. Despite their vastness, the oceans of the world resemble large aquariums. Both are filled with peculiarly sensitive organisms. As we continue to dump wastes and spill oils and chemicals into the oceans, we may find that man can ruin the seas much more readily than the land.

Protocol at the Annual Brown Bear Fish Feast

Lewis and Clark's first reference to the brown bear was that it is hard to kill. This entry in their journals connotes an attitude toward these powerful and agile animals that is still prevalent. In combination with a widespread destruction of habitat, the belief that man and bear are incompatible has been instrumental in eradicating the brown bear from most of the conterminous United States. The bears had formerly ranged west from Ohio to California and south from Canada to Mexico; today, after 150 years of pressure from man, they remain in only a few scattered pockets in Montana, Idaho, and Wyoming, and in the sanctuaries of Yellowstone and Glacier National Parks.

The bear encountered by Lewis and Clark was commonly called a grizzly, considered by taxonomists to be the same species, *Ursus arctos*, as the Kodiak, Alaska brown, and European brown bears. Only the brown bears of Alaska and northwestern Canada still range widely in a pristine environment where the lack of human development has allowed them to survive in numbers. Attempting to identify their needs for survival, for the past five years I have studied the social behavior of these huge omnivores in their undisturbed habitats on the Alaska Peninsula.

Under normal circumstances, the coastal Alaska brown bear is a distinctly asocial animal. With the exception of mothers with cubs, recently independent sibling groups, and mature adults during mating season, two bears are not likely to be living together or even cooperating. This pattern of behavior is maintained from the time the bears emerge from their dens in the spring until they gather to feed on spawning salmon during the summer months. Before the salmon come in from the ocean, the bears survive as vegetarians, except for an occasional ground squirrel or piece of carrion. Their food sources range over a wide area, and there is enough room for each individual. If two bears meet during this period, there is usually an aggressive encounter, but the loser can easily find another spot where the grass is just as green.

When the salmon enter their spawning streams, however, they create limited and highly preferred food sites, forcing the bears to adapt their behavior to fit what is, in effect, a continuous social situation. This adaptation is crucial to the bears' fishing success and, very likely, to their survival through the leaner winter months ahead.

The rules are quickly and forcibly established so that everyone can get down to the serious business of eating

by Derek Stonorov

The last two years of my study have been devoted to the social organization of the bears at one feeding area within the small McNeil River Bear Sanctuary, where every July and August there is probably the highest density of bears anywhere in Alaska. The sanctuary is owned and maintained by the Alaska Department of Fish and Game for the purpose of scientific research and photography. Hunting is prohibited within the sanctuary.

Flowing eastward out of the mountains of the Aleutian Range into Cook Inlet, the McNeil River is only 25 miles long, but its upper reaches are the spawning ground for thousands of chum salmon. The only obstacle between the salmon and their spawning beds is a series of rock slabs known as the McNeil River Falls. Schools of salmon enter the river with high tide and quickly swim the mile upstream to the bottom of the falls. Here, unless the river is high, the milling fish bunch up in groups of hundreds, even thousands, until they can find a way through 200 yards of white water so swift that in places it can knock a 750-pound bear off its feet. Above and below the falls the water is too deep for bears to catch salmon readily, but at the falls it is shallow, and frequently a fish is half out of the water as it wriggles up a riffle or jumps a falls, thus becoming vulnerable to predation by the waiting bears. At the height of the salmon run, a bear may average up to four fish per hour, while above or below the falls it would do well to catch one fish in the same time.

Up to thirty bears may use the area at the same time, with as many lingering in the immediate vicinity—sleeping, resting, or feeding on plants. The heaviest fishing pressure takes place in the late afternoon and early evening when some bears spend up to six hours at a stretch in the immediate area. With such a high density in a limited area, the development of a stable social organization to minimize fighting and allow the maximum time for fishing would be highly advantageous. To determine if any such organization exists, I observed more than three thousand encounters in which dominant and subordinate individuals could be distinguished, an encounter being any situation where two or more bears reacted with each other in such a way as to disrupt their ongoing patterns of moving, feeding, or resting. Information gained by recording who won or lost, and to whom, clearly showed that the bears had

evolved a definite social hierarchy.

Four situations lead to the encounters upon which the hierarchy is based: (1) violation of the individual distance around an animal, which causes it to attack or flee; (2) redirected aggression by the loser of an encounter, who then takes out its feelings on a third bear; (3) competition for a choice fishing spot; and (4) the initial meeting between two strange bears, which often results in a fight that establishes their ranking and relationship to each other for the entire summer.

This type of hierarchy breaks down into groups based on size, sex, and reproductive condition. Bears in each group are generally submissive to those in higher-ranking groups, but are aggressive among themselves since there are positions of rank within each group. The top-ranking bears tend to be the largest males, and one of these, called the alpha male, ranks over all others in all situations. The large males are followed closely by sows with cubs; females not raising young rank lower. Next are sibling groups, which travel together and display their intentions toward other bears as a unit. On the bottom of the hierarchy are the small males and females; males tend to rank higher but size and age are important factors in their social position.

Large males are in a class by themselves. Some may weigh more than 750 pounds, twice the size of a mature sow, and three or four times as large as an immature individual. When a high-ranking male arrives, all those nearby give him room; some leave altogether.

Sows with cubs have varying ranks, depending upon the age of their young. Those with yearling or older cubs tend to rank higher because their cubs join in aggressive displays, while the mothers of younger cubs have to concentrate more on the immediate needs of their offspring. Sows with spring cubs frequently have to turn around in the middle of a display to see where their cubs are, as the young often become frightened by the sounds of the encounter. Yearling cubs get right in there and display beside their mother, matching her display in miniature style, but for the most part keeping clear of any contact.

All sows with cubs are defensive to the point of being offensive. They are constantly aggressive toward bears that wander too close to their offspring. If given room, they are likely to let things go on peacefully, but if pressed, they will attack and frequently make physical contact with an adversary. It is not uncommon to see a sow with a cub smack an unsuspecting large male that has wandered too close. But these males are aware of the ways of irate sows and do not bother to fight back.

Sows without cubs will defend themselves and choice fishing spots, but with no young to feed they do not have too much to lose if moved. Although more easygoing, they do not tolerate close proximity by smaller bears that rank below them.

Sibling groups stay together for two to three years after they are abandoned by their mother, and such groups can dominate all individual subadults in their area. Some dominated bears may even be older and larger than those in the sibling group. They were very likely in a sibling group themselves before the bond keeping them together weakened and they went their separate ways. Members of sibling groups may become separated for short periods of time, and an examination of individual members' won – lost records during these separations shows that they may drop as many as fifteen places in the hierarchy when they are alone, falling in rank to social stations far below those bears they dominated as a group.

The hierarchy is by no means static, and reversals between bears are common. A bear full of fish may move out of the way of one slightly subordinate that has not eaten for a few hours. The alpha male may be particularly aggressive toward an up-and-coming rival and force him to leave for parts unknown. Special relationships also exist. One large sow may outrank a small male, but tolerate him if he behaves correctly at distances as near as a few feet. Rank is particularly difficult to pinpoint at the bottom of the hierarchy, where socially immature subadult bears, not having attained sexual maturity, coexist peacefully.

Bear communication involves the senses of smell, hearing, and sight. Simply because of a fascination, I have concentrated my field research upon the behavioral characteristics used in visual communication that function to modify the behavior of an opponent. These modifying characteristics occur in predictable sequence and combinations, and I have been able to identify forty-five such vision-associated signals.

The most obvious signals are the locomotor activities: approaching or retreating in a walk or run, crouching, lunging, circling, backing up while facing an opponent, standing stock still, or just sitting down. A subordinate may even lie down and approach a dominant bear like a fawning dog.

In conjunction with these locomotor activities, signals are given in a stationary position by means of either frontal or lateral body orientation. Because of their short tails and long fur, bears cannot use most of their bodies as effectively as some other animals to convey information to opponents, and so the head, neck, and mouth are frequently used for this purpose.

The position of the head is a significant indicator of a bear's mood. There is an Aleut saying that you can tell a dejected bear because he walks along slowly with his head down, and beware of dejected bears. A head-down position, in which the head is lower than the hump at the shoulders, signals that the bear is reacting to an adverse stimulus, and some form of aggressive behavior can be anticipated. Conversely, a head held above or level with the prominent hump frequently indicates a low level of aggression. During a particularly intense display, a bear may twist or tilt its head sideways, making a

From a good fishing position in the shallow water between rock slabs, a young male emerges with his catch of spawning salmon.

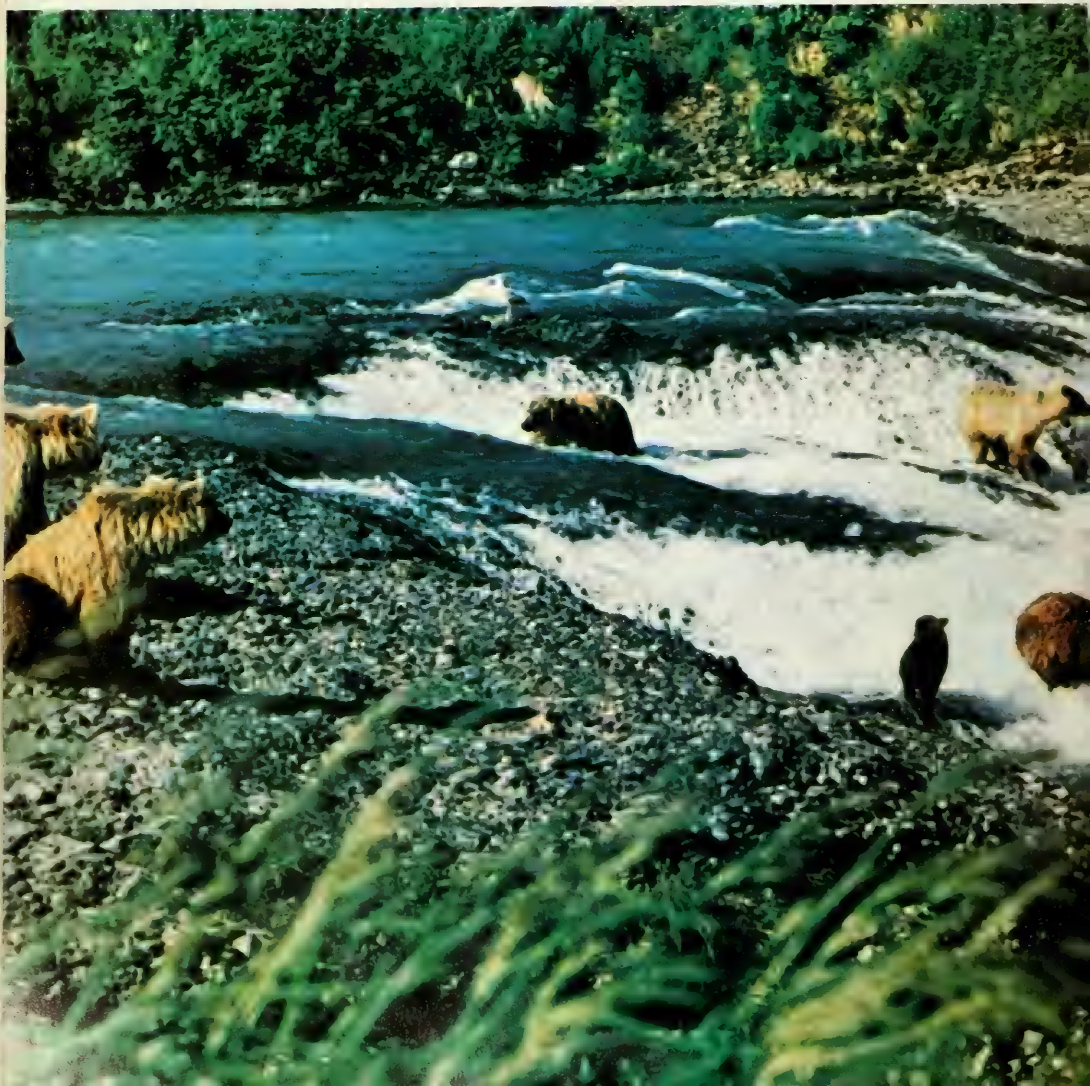
At 2½ years of age, this sibling group has split off from its mother, but still functions as a unit. Female at lower right was the only successful fisher, and part of her catch was eaten by the other two, a male and a female.

Lower-ranking bears wait their turn as dominant animals monopolize the most productive fishing spots at the McNeil River Falls.

clear biting threat; or, should one of the protagonists want to break off an engagement, it will suddenly and dramatically drop or turn its head away from its opponent, which may be standing only a foot or so away.

The opposite of a face-away display is a face-stare. This display, which involves a long look at a potential opponent, has a great effect at times. An old male may put this sort of whammy on a subadult or on another large male. One time I saw a huge bear come up behind a small subadult that was intent on catching a fish. The young bear either heard or smelled the old male when the distance between them was only about five feet. It turned around, beheld the large bear looking him right in the eye, and promptly fell over backward into the water.

Use of the mouth also plays an important role in aggressive behavior. A bear may go through an entire encounter with its mouth closed, or the mouth may be open but the large canines kept covered. If the bear is really aroused, the canines are conspicuously exhibited. A variation of this behavior is the mouth-working display, in which



the mouth is opened and closed rapidly, accompanied by heavy salivation. Since I can't statistically prove that this behavior actually affects the reactions of other bears, I am not sure of its value, but I have had it modify my behavior on several occasions. A chomping noise can be easily heard as the mouth opens and closes; my response is usually a back-up display.

Sometimes during the course of an encounter one bear may bite or take a forepaw swipe at an opponent. This contact is rare and is usually only seen in sows with cubs in tow chasing an individual that wandered too close. It can also occur during some of the spectacular fights between two large males. But out of the several thousand encounters I have witnessed, not one has resulted in a crippled bear. Several times, sows with cubs bit pesky subadults. Such bites would undoubtedly have inflicted severe damage to less powerful species, but the young bears showed few adverse aftereffects. One large male literally picked up a rival in its mouth during a fierce encounter. As part of a marking study the 750-pound victim was later tranquilized and examined thoroughly. We found that a piece of hide 4 inches by 5 inches was missing and that the bear had been bitten down to its ribs. In spite of the injury, he was back fishing the day after the fight.

Many large males carry scars; some probably come from dominance fights like this one, and others come from fights over females during the mating season in May and June. If one reads accounts of the bull and bear fights that were staged in California during the

Continued on page 90

The Candy-Colored

now-Flaked Alpine Biome

The producers of the red tide and green pond reach a higher level

by John T. Hardy
and
Herbert Curl, Jr.

Vast fields of blinding whiteness blanket the upper flanks of high mountain ranges. The snow dazzles the eye, but a closer view often reveals large, tinted patches of red, green, yellow, orange, or purple. These swatches of color, which have perplexed generations of mountain climbers, are increasingly drawing the attention of scientists because they indicate the presence of unusual and highly specialized forms of life.

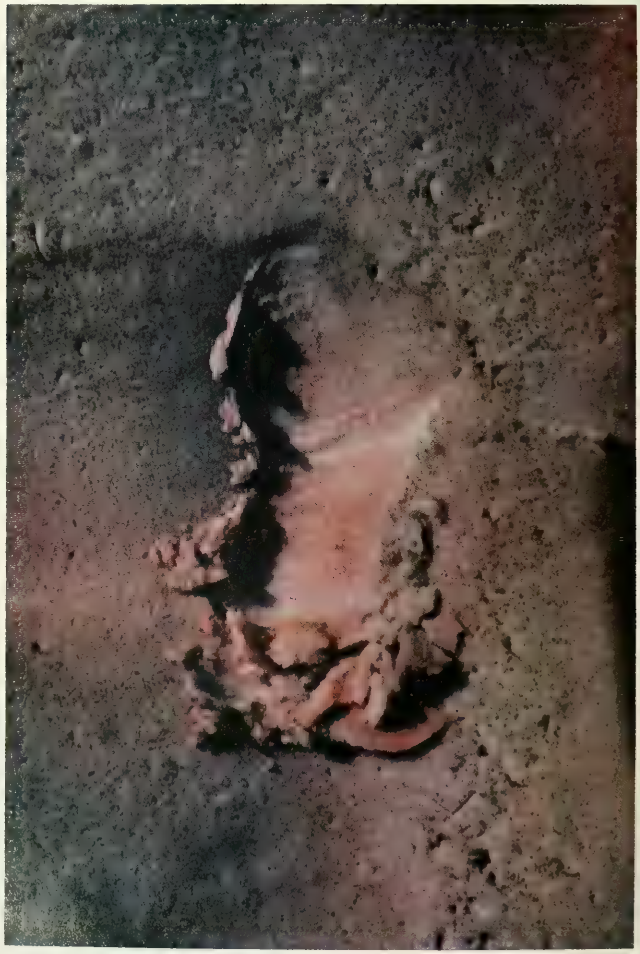
Aristotle mentioned colored snow centuries ago, but it was not until the early nineteenth century that scientific examination of the phenomenon began. In 1818, John Ross, the Arctic explorer, discovered an eight-mile expanse of red-colored snow cliffs overlooking Baffin Bay. He collected samples of the red snow, bottled them in a preservative, and upon his return to England, presented them to several noted British biologists. Using the techniques available at the time to study the samples, some of the biologists attributed the red color to the presence of fungi, but others thought it was caused by plants or animals. By the late nineteenth century biologists recognized that col-

Chlamydomonas nivalis,
a widespread algal species,
adds bands of color to a
midsummer snowbank at 10,000
feet in the Front Range
of the Colorado Rockies.

ored snow resulted from high concentrations, or "blooms," of microscopic algal plants. Since that time, investigators have identified more than 100 species of snow algae and mapped their geographic distribution. But information on the ecology and physiology of the snow flora is still scarce.

Many snow algae have a worldwide distribution. Some of the same species occur in the snowfields, glaciers, and alpine areas of Europe, North and South America, Australia, Japan, Antarctica, and Greenland. The red cells, or resting spores, of *Chlamydomonas nivalis* are probably the most common and widely distributed type. Great numbers of these cells produce the watermelon color commonly observed on alpine snowfields. Other widespread forms are the diatoms found growing in sea ice. Many species are less widely distributed, however, and are sometimes known only from a single collection at one geographic location. In the United States, at least 60 species have been identified in the snowfields and glaciers of the Rockies, Olympic National Park, Mount Rainier, the Cascade Ranges, the Sierra Nevada, and in Alaska.

A resting spore of *Chlamydomonas nivalis* reproduces by releasing four "daughter" cells. The specimen, photographed at 400 times magnification, was collected at 6,000 feet on Mount Baker, Washington.



By July, *Chlamydomonas nivalis* is thriving in the granular snow from the previous winter. A footprint has compacted the top layer of snow, increasing the density of the red cells and heightening the color.

Algae were probably the earliest photosynthetic plants on earth. Phycologists generally divide the great diversity of living algae into seven major taxonomic divisions, many of which are represented among the snow flora. The true number of valid species of snow algae will not be known, however, until further work on their life histories is completed.

They are all microscopic, ranging from the one micron size of a bacterial cell up to 100 microns, and are mostly unicellular or living in small colonies in which several cells are joined end to end. The algal cells also come in a variety of shapes—cylindrical, spherical, or spindly.

As in most plants, the cells contain chlorophyll and utilize solar energy for photosynthesis. Many types also contain large quantities of the red, orange, yellow, blue-green, or purple pigments that are responsible for the appearance of colored snow. Reproduction in different species is accomplished by simple division into "daughter" cells, by the formation of spores, or by the fusion of "male" and "female" reproductive cells. A few species have now been grown in artificial cultures in the laboratory, enabling researchers to learn more of their life histories and physiology. Dr. Ronald Hoham of Colgate University, for example, has recently found that several snow algae among the genus *Chlamydomonas*, which had been thought to represent different species, are probably variously colored stages in the life cycle of the same species.

While the effects of temperature, light intensity, dissolved chemical nutrients, freezing, thawing, and grazing by microfauna on the abundance and growth of snow algae have not yet been fully determined, it is obvious that these algae must be extremely hardy and resistant to environmental extremes. Our studies and those of Hoham indicate, for example, that unlike other plants, some snow algae grow and photosynthesize optimally at near-freezing temperatures. Others can withstand being frozen in ice for long periods of time. We have kept resting cells of *Chlamydomonas nivalis* viable in a dried and frozen condition for as long as seven years after collecting them.

Studies of snow algae in the northwestern United States and Antarctica indicate that the snow flora consists of at least two temperature types. One type does not require low temperatures to live and grow, but is probably restricted to cold habitats because it cannot compete successfully with freshwater species found in higher temperature environments. *Stichococcus bacillaris*, for example, is sometimes found in snow samples, but is a common alga that grows in soil at many temperatures, including hot springs, and can even be grown successfully in a seawater medium. Other species, such as *Chromulina chionophila* and *Chlamydomonas pichinchae*, represent true cryophilic (cold-loving) types, which can grow only at temperatures that are slightly above freezing.

Nitrate, phosphate, and many other chemicals are essential for the growth of all plants, and analyses indicate that such substances are present in snow, where they are either concentrated by sublimation or diluted by rainfall. Antarctic snow contains higher amounts of dissolved nitrate and phosphate than North American snow and is richer in algal species. Some of the Antarctic algae may receive fertilization from penguin feces.

Snowfields at higher elevations receive intensely bright light, and because only a thin layer of atmosphere is present for filtration, the solar rays contain a greater proportion of blue and damaging ultraviolet wavelengths than at sea level. Some snow algae, such as *Chromulina chionophila*, possess a photoreactivation enzyme that can repair the damage done by ultraviolet radiation to the chlorophyll and other photosynthetic pigments.

The relationships between dissolved chemical nutrients, light intensity or quality, and the growth of snow algae remain unclear. We know that in other aquatic environments, optimum levels of light and nutrients can result in the rapid growth of large numbers of algae. Such environmental factors might also control the colorful spring and summer blooms of snow algae, as well as their variations with season and altitude.

In spring and early summer, the algae grow most abundantly near the surface of old, melting snow, although the resting spores can be found down to a depth of more than two feet. By late summer, the algae have vanished from areas where the snow has melted; but where there is permanent snow, they may remain until autumn when heavy snowfalls begin to cover the old surface. With spring, algal cells suddenly reappear and another growth cycle begins. Like other life forms, snow flora requires liquid water for active metabolism and growth. The increased presence of liquid melt water in spring, as well as increasing quantities of solar energy, are probably important factors in stimulating the growth and blooming of snow algae.

During the summer, algae such as *Chlamydomonas* accumulate in shallow depressions in the snow called sun cups. Because the dark red pigments of the algae absorb solar energy, the cells melt their way into the snow, deepening the sun cups and increasing the melting rate of snowfields and glaciers.

How are the algae "reseeded" on the surface after each winter's snow accumulation? Various hypotheses hold that they are distributed by one of the following means: (1) carried by wind currents, resting spores from adjacent snow-free land areas settle on the high-altitude snowfields; (2) birds carry the algae in their intestinal tracts or inadvertently stuck to their feet and feathers; and (3) resting spores present in the soil or in deep layers of the snow pack produce motile cells that swim to the surface and grow.

Present evidence, at least for *Chlamydomonas nivalis*, favors the last of these hypotheses. Experiments by Emory Sutton and others at Oregon State University indicate that these algae lie dormant in the soil under snowfields during winter. Then in the spring, under the right combination of melting snow, light intensity, and possibly photoperiod, the resting spores produce green, flagellated cells that swim upward through the snow pack to the surface. Our studies on *C. nivalis* show

that the cells contain a proteolytic enzyme that can dissolve a plug area in the thick cell wall of the resting spore. Suitable environmental conditions probably initiate the synthesis of this enzyme by the alga and the subsequent release of motile cells.

A unique fauna is associated with snow algae communities. During the last part of the nineteenth century several scientists reported that large numbers of snowworms inhabited the snowfields and glaciers of Alaska, Washington, and California. During an 1891 expedition to the Malaspina Glacier in Alaska, Dr. Israel Russell observed large numbers of worms and later wrote:

"In the early morning before the sunlight touched the snow, its surface was literally covered with small, slim black worms, about an inch long, and having a remarkable snakelike appearance. These creatures were wiggling over the snow in thousands. . . ."

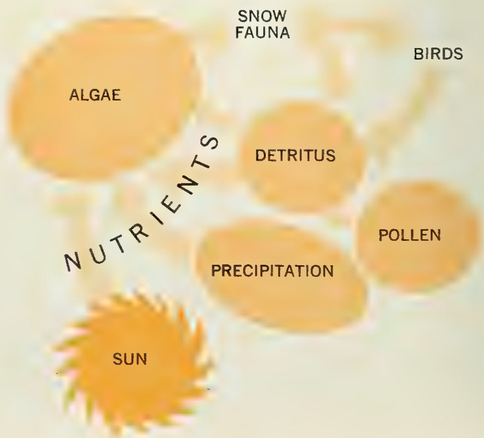
Many species and varieties of snow and ice worms are now known. All are segmented, and belong to the genus *Mesenchytraeus*. While these worms occur most often during spring and summer on snowfields that melt toward the end of summer, they are also found on the snow of permanent glaciers. Like snow algae, they are not found during the winter months. Various species of protozoans, ciliates, rotifers, nematodes, spiders, and springtails are other members of the miniature snow fauna that find the cold realm a suitable habitat.

As photosynthetic plants, algae represent the "primary producers" of the world of snow and ice and may form the beginning of a unique food chain. We know, for instance, that worms and springtails tend to occur in association with the algae. Also, at least a part, if not all, of the diet of snowworms consists of algae; and several authors have reported finding red *Chlamydomonas* cells within the guts of snowworms and rotifers. The worms and rotifers can thus be considered the herbivore "grazers" of the snow ecosystem.

A "decomposer" chain may also occur in old snowfields. The surface of old, melting snow often collects great quantities of detrital material (particularly pollen) and organic matter windblown from nearby trees. This material, along with dead algae and snow animals, can support large populations of bacterial decay organisms. By breaking down such detrital organic matter, these bacteria again make essential chemical nutrients available for the growth of algae. Birds form the final "predatory" link in the food chain by feeding upon the herbivorous snowworms and springtails.

As the ecosystems of colored snow are examined in detail, the existence of life in such a harsh environment appears increasingly fascinating. The survival of minute plants and animals in an icy habitat is a microcosm of ingenious adaptation.

Food Chain of an Old Snowfield



From Calcutta ...

Report on Elizabeth Dass...

CHRISTIAN CHILDREN'S FUND, INC.
CALCUTTA, INDIA - CASEWORKER REPORT

REC'D CHRISTIAN CHILDREN'S FUND, INC. Richmond, Virginia

TO NAZARETH HOME, CALCUTTA

DATE: MARCH 17, 1969

NAME: ELIZABETH DASS

DATE OF BIRTH: APRIL 12, 1964

NATIVE PLACE: CALCUTTA

ORDER OF BIRTH: THIRD DAUGHTER

HEALTH: FRAIL, THIN, WALKS ~~XX~~ WITH DIFFICULTY, PROTEIN DEPRIVED

CHARACTERISTICS: GENTLE, QUIET, COOPERATIVE. SPEAKS CLEARLY AND IS OF GOOD MIND. WILL BE ABLE TO LEARN ONCE HEALTH AND STRENGTH ~~XX~~ ARE RESTORED.

PARENT~~XENXS~~CONDITION: FATHER: DECEASED.

MOTHER: MALNOURISHED, RECENT VICTIM OF ~~XXX~~ SMALLPOX, WORKS IN A MATCH FACTORY.

INVESTIGATION REPORT:

ELIZABETH'S FATHER USED TO BE A STREET CLEARNER, DIED FROM TYPHUS. HER MOTHER IS VERY WEAK FROM HER RECENT ILLNESS-INDEEDIT IS REMARKABLE SHE IS ALIVE AT ALL. ONLY WORK AVAILABLE TO THIS WOMAN IS IN A MATCH FACTORY WHERE SHE EARNS TWO RUPEES A DAY (26¢) WHEN SHE IS STRONG ENOUGH TO GET THERE AND WORK.

HOME CONDITIONS: HOUSE: ONE ROOM BUSTEE (HOVEL) OCCUPIED BY SEVERAL OTHER PERSONS BESIDES ELIZABETH AND HER MOTHER. HOUSE IS SO SMALL COOKING IS DONE ON THE FOOTPATH. BATHING IS DONE AT A PUBLIC TAP DOWN THE ROAD. PERSONS LIVING WITH THEM IN THIS HOUSE ARE NOT OF GOOD REPUTE, AND THE MOTHER FEARS FOR ELIZABETH.

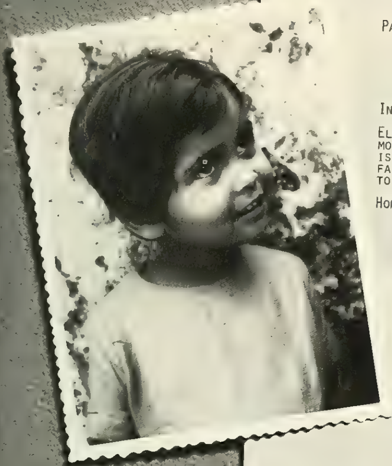
SISTERS:

MARIA DASS, DECEASED OB SMALLPOX
LORRAINE DASS, ALSO DECEASED OF SMALLPOX
(ELIZABETH FORTUNATELY ENTIRELY ESCAPED CONTAGION)

REMARKS:

ELIZABETH WILL CENTAINLY BECOME ILL, PERHAPS WILL TAKE UP THIEVING, MAYBE EVEN MORE TERRIBLE WAYS OF LIVING, IF SHE IS NOT REMOVED FROM ~~XM~~ PRESENT HOME CONDITIONS. HER MOTHER IS WILLING FOR HER TO GO TO NAZARETH HOME AND WEEPS WITH JOY AT THE HOPE OF HER LITTLE ~~SX~~ DAUGHTER BECOMING SAFE FROM THE WRETCHED LIFE THEY NOW HAVE.

STRONGEST RECOMMENDATION THAT ELIZABETH DASS BE ADMITTED AT ONCE.



Elizabeth Dass was admitted to the Nazareth Home a few days after we received this report and she is doing better now. Her legs are stronger . . . she can walk and sometimes even run with the other children. She is beginning to read and can already write her name.

Every day desperate reports like the one above reach our overseas field offices. Then we must make the heartbreaking decision—which child can we help? Could you turn away a child like Elizabeth and still sleep at night?

For only $12 a month you can sponsor a needy little boy or girl from the country of your choice, or you can let us select a child for you from our emergency list.

Then in about two weeks, you will receive a photograph of your child, along with a personal history, and information about the project where your child receives help. Your child will write to you, and you will receive the original plus an English translation—direct from an overseas office.

Please, won't you help? Today?

Sponsors urgently needed this month for children in: India, Brazil, Taiwan (Formosa), Mexico and Philippines.

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CHRISTIAN CHILDREN'S FUND, Inc.

Box 26511, Richmond, Va. 23261

I wish to sponsor a ☐ boy ☐ girl in

(Country)________________

☐ Choose a child who needs me most. I will pay $12 a month. I enclose first payment of $________.

Send me child's name, story, address and picture.

I cannot sponsor a child but want to give $________.

☐ Please send me more information

Name ________________

Address________________

City________________

State________________ Zip ________

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The Uncertain Future of the Tropics

"The developed nations should return some of the resources ripped off the tropics over the past 400 years"

The practice of sustained-yield agriculture, with its long-range planning and consistent crop returns, is gradually replacing exploitative farming methods in many temperate zone countries. This approach will help the developed nations to continue their high standards of living.

Paradoxically, the ethnocentric attitudes and misconceptions held by scientists and policy-makers in the temperate areas have often hindered tropical countries from adequately feeding their people and preserving their environment. The disregard for ecological principles that is so dramatically evident in the rapid exploitation and destruction of tropical habitats is commonly viewed in temperate zone countries as an expression of ignorance. The widely held opinion is that the governments involved must be lacking the appropriate scientific information and expertise with which to formulate better land-use policies. This condescending, elitist judgment results in the susceptibility of developed countries to the argument that they should fund research to gather more data on tropical habitat utilization.

Ecologists and policy-makers of this persuasion are prone to avoid the more direct explanation that the lack of ecological planning is frequently dictated by exploitation programs that are of immediate advantage to certain individuals or governments. For example, an administration may of necessity be more concerned with meeting the press of immediate food shortages than with instituting long-range, sustained-yield agroecosystem programs that will initially support fewer people at a higher standard of living. Green Revolution strains of grain, which have an immediate high yield but which may have disastrous long-term effects, are eagerly anticipated. Even when sound management principles are expounded, such as those expressed by the excellent game and timber harvest laws on the books of many tropical countries, they are rarely applied, and then generally only when it benefits a vested economic interest.

The absence of a sound ecological perspective in tropical habitat manipulation is basically due to the desire to produce results incompatible with long-term management programs based on sustained yields. This applies on all levels: from the farmer who wants quick money for a new radio, to the government that wants to convert its forest reserves into cash for guns to protect its borders from a country that some years ago converted its forests into cotton fields and is now looking for more land for its hungry population. High, immediate returns have been harvested from many tropical agroecosystems, but at the expense of the natural "capital" that could have been used to generate the "interest" harvested in sustained-yield agriculture.

The result has been the gross failure of the decision-making processes in these countries to incorporate what the scientific and folklore communities already know about tropical ecology and its applications. The problem will not be alleviated by further research of the type classically conducted by tropical biologists from the temperate zones: such esoteric research will have little or no direct impact on the rates, directions, and quality of the conversion of tropical natural habitats into living machines for the production of society's desiderata. Habitat manipulation will continue to be performed primarily by the application of resource-management technologies, ranging from age-old farming traditions to the integration of genetic and biological control programs, and by technological innovations, such as converting wood from rain forests into cattle feed and building better mechanical peanut pickers.

This, of course, is basically the same situation that marked the development of the temperate zones, but the future for the tropics will

If you've ever stood by the shore and listened to the pounding surf . . . felt the clean, refreshing shower of spray after a crashing wave . . . smelled the bracing breeze filled with the tang of salt green waters . . . then you have some idea of what Wind Drift is like.

Wind Drift. The new after shave and cologne by the makers of English Leather® Beautifully boxed in authentic cork design gift sets.

It's like splashing on a wave after you shave.

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Wild River
Laurence Pringle

be much bleaker unless policies and practices affecting resource uses are changed.

The dust bowls of the American Midwest have been regenerated to a productive state through large-scale emigration of the soil-tillers, imported fertilizers, and fossil fuel technology. In the tropics, however, much of the lowland vegetation and the associated animal community have been permanently destroyed, and the soil structure is rapidly following. Tropical countries still do not possess the wherewithal of an America of the 1930s and 40s to arrest this destructive process.

The current definition of the tropics as those areas with moderately predictable weather and year-round, strong solar radiation underscores the problems in obtaining the necessary understanding of the region. It bolsters a grossly erroneous impression held by most temperate zone scientists and policy-makers. Their research efforts and decisions reflect a strong bias toward thinking of the tropics as a single unit rather than as a collection of problems and resource bases. The ecology of droughts/subsistence agriculture/trans-Amazonian highways is as different from that of rubber/paddy rice/herbicides as the ecology of grapes/tourists/Mediterranean winter rains is from that of Douglas fir/SST/rain forest.

There is far more basic diversity of habitats and resource bases within the tropics than outside them. These habitats and their indigenous cultures have been invaded by a wide variety of cultures and economic practices that evolved in the seasonal pulsed-energy systems of the midlatitudes. This heterogeneity and the predictability of the tropical environment at any particular site allows many different solutions to resource use, each of which may be as profitable as the other. This has resulted in a great variance in management programs through personal idiosyncracies.

Compounding the confusion often created by conflicting proposals, esoteric ecologists, whose primary goal is to understand nature, and management-oriented researchers, who wish to manipulate habitats, have become polarized in

their respective approaches to tropical ecology. Checking the validity of an approach recommended by a member of either camp is made extremely difficult by the fact that peer judgment, that bastion of quality control in science, is a nearly useless tool because of the paucity of peers. It is rather easy to be an unquestioned world authority on the ecology of Central American acacia ants, the silviculture of mahoganies, or the foraging behavior of weaver finches when you are the only scientist in the country with firsthand experience in the subject.

Also, in view of the extreme diversity of tropical systems, the traditional ecological approach of constructing a generalized ecosystem model upon which to base resource use decisions is highly impractical. An over-all model detailed enough to deal simultaneously with all appropriate sites would require an inordinate amount of time to produce and maintain in the face of changing needs and technologies. As the pace of tropical habitat exploitation is increasing dramatically, such time is simply not available.

Because of its inherent generality, such a model would require extensive study of natural ecosystems. A good deal of attention would be given to documentation of community-wide energy-flow patterns, productivity, maintenance metabolism, and so forth. It is highly questionable that any of the general statements produced by such a study (for example, "tropical lowland rain forest has the highest productivity of any habitat on earth," which may well not be true if we look at *harvestable* productivity) are useful to the development of a sustained-yield ecosystem. As a Southeast Asian biologist recently said: "But how important is productivity? The [over-all] productivity of a crop plant is only of importance insofar as it affects the yield of the economic part of the crop. The rice planter is interested only in the harvest of rice grain, the rubber planter in the yield and quality of latex, and the oil-palm grower in the yield of palm oil. Whether these objectives are ob-

tained from plants with high or low productivity is immaterial."

To use a temperate zone example, the highly successful agricultural ecosystems of temperate zones were developed with virtually no understanding of natural systems. To maximize stable corn production in Iowa, a knowledge of undisturbed prairie productivity is unnecessary. If there is anything at all in common between natural-, quasi-natural-, and agroecosystems, it is the individual control mechanisms and the principles of their functioning. These are the very aspects of ecosystem models that receive least attention.

A completed tropical ecosystem model could even be a very obstructive device. Its structure would necessarily be based on statements of central tendency, as would its predictions. Tropical man's needs frequently deviate widely from standards determined by averages taken over all the energy flows or units in an ecosystem. Adherence to such models is also likely to greatly delay the development of innovations (such as converting forest directly to cattle food). This adherence is especially likely in tropical economic-social systems where "elegant science," with all its prestige-building trappings (computers, foreign aid programs, big-name scientists, systems analyses, elegantly illustrated publications, and new equipment with sophisticated technology), is often treated with greater reverence than is merited by its information content or pragmatic value. Further, the presence of such an official "solution" causes researchers to try to use it (much as there is the temptation to use a faulty tool rather than to construct a new one), thereby becoming distracted by the inability to apply a technique rather than focusing on the true problem at hand. The highly formal educational systems of many tropical countries tend to generate a predilection for this error in tropically trained technicians.

The diversity of the tropics is so extreme that pragmatic returns would be far greater through ecologically sound regional development than through general ecosystems models. Agricultural experiment stations for each of

the major ecosystems should be established on a regional basis, each working toward a realistic set of sustained-yield solutions for each region. This would be in striking contrast to the current reductionist approach of tropical experiment stations, where almost all effort is directed at yield improvement. The basic ecological background already shared by the global scientific and folklore communities is an adequate knowledge base to initiate such a program. Detailed information would be obtained as needed through direct, large-scale experimentation at the station and on subleased neighboring land. Under this approach, each tropical agroecosystem is treated as unique. Scientific linkage among the agroecosystems would be provided through publications and a greatly increased exchange of personnel among field stations.

For such a system to develop viable sustained-yield programs over a large area it will need the power to overrule private interests; for example, such would be the case in an attempt to control insecticide resistance in cotton pests through sequential cotton-free years on a regional basis. Obviously, the system would have to be managed by dedicated persons commanding the respect of scientists, local landowners, and the political powers of the country itself. Such a state of affairs would be the opposite of the current status of most tropical experiment stations.

The system being proposed here is very susceptible to biological imperialism from well-meaning, but nevertheless destructive, temperate zone countries. Major sets of policy decisions must be made as to whether the regional experiment station is to aid and abet a self-contained agroecosystem, with most of the produce going to raise the standard of living of that region, or whether it is to produce an ecosystem highly integrated with the rest of the world. A clear example is whether to generate a coffee-based economy, and use the cash to provide goods and services, or go to a much more diverse agriculture and land-use program that will have little output to temperate zone countries. When

providing economic or educational assistance, it is extremely difficult for temperate zone countries to avoid the temptation of structuring their aid in a manner that will destroy self-sufficiency on the part of the tropical ecosystems.

The problem is to interest the tropical decision-makers in the incorporation of sustained-yield systems into their agroecosystem development plans. I cannot help but be cynical as I look around me in the tropics: it seems that it will take a drastic degeneration of tropic agricultural ecosystems until the lack of ecological planning is identified and felt strongly. At that point, economic and social forces will begin to incorporate their own checks and balances. The land's ability to support a population at an adequate standard of living will by then be at some low level, depending on the intensity of destruction of natural capital up to that point. Most likely no semblance of natural habitats will remain—even as national reserves. The critical question, then, would become how much of the natural capital has been permanently destroyed, requiring a permanently lower human population density for a given standard of living. Such a gloomy scenario should not obscure the obvious fact that there are ways to determine the human carrying capacity of a habitat without such dramatic countrywide or global destruction. These methods are where the first priority should be in funding.

Even our crude level of understanding of tropical ecology is adequate to recognize the following major areas where money invested would yield very positive returns:

(1) Tropical decision-makers are usually provincial in their firsthand experience with agroecosystems. When they do have the opportunity to study abroad, it is generally in temperate zone countries. They should have the financial means to view and work with those few functioning sustained-yield harvest systems that are scattered about the tropics.

(2) These authorities are likewise unfamiliar with the ways that tropical agroecosystems outside their own country have repeatedly

gone awry. They are badly in need of an educational system that communicates and produces scenarios based on real examples drawn from around the tropics. Must each country have its own failures at official land colonization by settlers drawn from urban slums or have to rediscover the interaction between large-scale cotton growing and insecticide resistance in tropical insects?

(3) When tropical biologists travel abroad for advanced training, they return home to a governmental hierarchy badly in need of ministers of agriculture, department chairmen, and bank vice-presidents who have technical expertise coupled with a broad education. They are quickly led or forced out of applied research itself and into administrative roles, substantially weakening the educational-research structure at its base. Funding is badly needed to bolster job security and other rewards for first-class researchers or teachers doing the job they were trained for. Suggestions are also in order for ways to minimize the administrative loads of tropical countries.

(4) The directors and assistant directors of tropical agricultural field stations, potentially the most important roles in the tropics, generally regard the job as a hardship post. It often becomes a nine to five job, or less, and is viewed as a necessary evil on the road to a top government post in one of the larger cities. Such a person is not likely to take an active interest in the integration of the results from his station's research into surrounding agricultural ecosystems or to search out actively the needs of his agricultural ecosystem and pursue them with research. Funds are badly needed to make this position an honorable and pleasant one, which holds the best people for long periods.

(5) Schools are devices for transmitting the rules that run our societies. We teach math, biology, chemistry, and languages because knowledge of these subjects will presumably be needed in the years ahead as the child grows. Teaching of the socioeconomic rules of a steady-state, nonexpanding economy, attuned to the concept of living within the carrying capacity of the country's or region's resources, is an

equally important subject from the first year in school.

Any hope for the conservation of representative and unique tropical habitats lies within these proposals. Vast tracts of most tropical habitats have already been mildly to severely altered by man's activities. Many of the animals and plants still remain (although often not as breeding populations), but the interaction systems that produced and maintained them through natural selection are often gone; much of the tropics has been converted into a haphazard zoo and botanical garden. One alternative could be the development of carefully planned regional agroecosystems. Plots of strategically placed and carefully chosen undisturbed natural vegetation could then be used for research by the esoteric ecologist, as well as for the preservation of native flora and fauna. It is obvious, however, that until the values of society change to where undisturbed habitats are regarded as having esthetic value in their own right, rather than being the environment against which man competes, as is currently the view in most of the tropics, the amount of land under this type of use would be minor. Also, large enough areas would have to be retained as reservoirs for plants and animals in order for populations to survive.

It should be emphasized that the concept of regional experiment stations is not just designed for breeding better strains of corn or cotton. They should have the personnel and resources to investigate and develop all aspects of an agroecosystem, in many ways filling the combined idealized roles of the United States land grant colleges of agriculture, fisheries, forestry, the associated state experiment stations, the United States Department of Agriculture, and some private companies. Temperate zone funding in the tropics should be far better spent in aiding and abetting such field stations than through the current vogue of funding large conferences where the same tired questions ("Are tropical soils fragile?" "Is subsistence agriculture consistent with the structure of modern society?") are pontificated on

by various people with a few years' experience in the tropics. Any competent director of a tropical experiment station could sit down for an afternoon and draft the same list of questions while looking out his office window. What he needs is the funding, equipment, and innovative scientific manpower to get to work on these questions for his own specific region. Planning the solutions of these problems from temperate zone offices should stop, and the developed nations should return some of the resources ripped off the tropics over the past 400 years. The repayment should be in the form of hard cash and technical expertise going directly into the development of regional sustained-yield agroecosystems. The details of the research should be the subject of discussions by the field station directors, staff, and whatever imported personnel are interested in direct involvement. If it is felt that block funding cannot be trusted to a particular experiment station, then some sort of review process could be generated whereby the reviewers at other experiment stations would participate, with occasional input by adequately experienced ecologists from other areas of the world.

The governments of tropical countries obviously have to come to grips with several policy questions before a steady-state agroecosystem can develop. A decision has to be made about the average standard of living and the frequency distributions of the individual standards of living. Further, the units in which it is to be expressed (income, suicide rate, education level, immigration rate) must be identified. Once this is done, planning councils can decide relatively easily how many persons the region can support and determine the needed intensity of personal population regulation and resource consumption.

The alternative to these propositions is, I fear, a continuation down the narrow, hopeless path that most countries are now taking. This road can only lead to a collapse of tropical ecosystems and an awesome increase in suffering for a large portion of the human species. ■

Protocol at the Annual Brown Bear Fish Feast

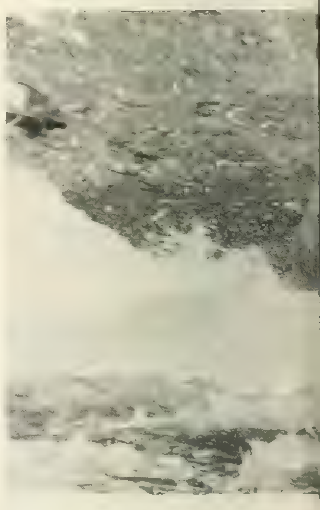
Continued from page 73

nineteenth century and notes the terrible destructive power that a bear possesses, one can easily understand the survival value of ritualized displays that stop short of actual contact.

Bears rarely stand up on their hind legs during an encounter. When they do, it is usually to increase vision in dense cover rather than to signal. Sometimes when two bears are engrossed in hitting at each other, both front feet may be off the ground at the same time, but this is certainly not the same posture that is so often depicted on the cover of outdoor magazines. Cubs, to keep track of their family group, will also stand up while feeding in high grass.

After an encounter a bear will often shake itself like a dog fresh out of water. Just how this body shake functions is uncertain, but it appears to have a correlation with the actual intensity of the encounter: the more intense the encounter, the more body shaking. It is possible that this behavior is related to stress.

From all of these individual signals and postures come some predictable stereotyped displays. One is a charge in which the head of the bear is oriented in the direction of the subject being charged. The neck is outstretched, eyes are pinned on the opponent, and the mouth is likely to be opened while a roar is emitted that can be heard a



A sow, left, approaches a male occupying a preferred fishing spot at McNeil Falls. As she moves in, center, she vocalizes loudly. Her ears are back and her mouth is open, but her large upper canines are covered. She keeps her body sideways to the boar to show she is not interested in combat. He also stands sideways, keeping his head up and away from her. Finally, bottom, the boar moves off. The low level of aggression indicates these bears are familiar with each other.

mile away. The canines may be showing, and the ears are flat against the skull.

A variation of this is the stiff-legged approach. The signals are the same as those in the charge, except that the animal approaches at a walk with its head down and muscles tensed, and its front knees appear to be locked.

A bear may also approach another in a crouch, with its body lowered, ears flattened, and emitting a low, bawling sound. This display is frequently used to persuade a subordinate to relinquish, without a fight, the fish it is eating.

Bears have markedly different distances around themselves. Killer, the alpha male at McNeil during our study, often allowed a subordinate female to fish within 50 feet of him because she posed little threat. But a slightly subordinate large male could pose a threat, and 100 feet would have been close enough. Luckily for wear and tear on tooth, claw, and hide, the bears soon learn each other's tolerances and keep their distance.

Sometimes when a bear loses an encounter it stalks off to beat up a subordinate. For instance, Majesty, another large male, was fishing when Killer appeared and started walking toward him, seemingly intent on the fishing spot Majesty was using. When Killer was 15 feet away, Majesty backed out of the spot, moved off downstream, and then suddenly swatted Big Momma, a large female engrossed in eating a fish. This was a likely case of redirected aggression, as he did not take her fish or her fishing spot. The dominant bears consistently hold the preferred fishing sites. When Killer comes down to fish, he is not going to go to fishing spots B, C, or D; he heads straight for A, the best place on the river. If it is occupied when he gets there, the interloper either fights or leaves in a hurry.

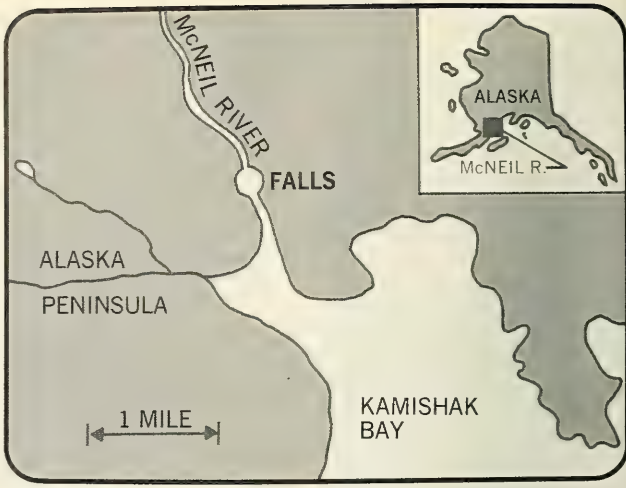
When two bears that are widely separated in rank confront one another, the dominant needs only to face the subordinate and advance slowly to make it move. At McNeil when a large male arrives on the river bank, all the bears within 100 feet usually move to other places.

Displays are much more blatant when the bears first arrive at the falls than later in the season. As the

fishing season progresses, the intensity and frequency of displays drop, running turns to walking, charging turns to stiff-legged approaches, and actual contact is replaced by hard stares. Less time is spent on aggressive behavior and fighting, more on fishing. One display does increase in frequency during the summer. This is jawing, a stereotyped, often mutual behavior of up-and-down head movements, with mouth open, ears back, lateral or frontal body orientation, and a stiff-legged appearance. A jawing bear gives the immediate impression that it is threatening a rival and is about to trigger a more assertive display. Mutual jawing is more likely to occur between bears familiar with each other than between those that have not previously met. It is also more likely to occur between animals that are close in rank. A jawing match might last only a few seconds, with one bear moving off, or it might go on for several hours between two bears fishing a few feet apart. Large males seldom, if ever, use this display with each other, nor do sows accompanied by cubs.

The formation of hierarchies and stereotyped displays are two important methods by which bears adapt to the crowded conditions at the McNeil River Falls. In addition, they also spread themselves out over space and time. The bears were observed to space themselves out by using at least twenty separate fishing spots, by using different paths, and by using different sides of the river. Many bears never crossed the river during the six-week season of 1971, thus cutting the possibilities of social contact by about 50 percent, as fishing tends to be evenly divided between the two river banks. The bears also made maximal use of the river by showing up at different times; each had a preferred fishing time.

The social tolerance and intolerance manifested in various forms of competitive behavior results in an advantageous division of the fishing resource. I have kept track of fish caught over a two-year period, and found that the success ratio correlates highly with social rank. Predictably, the most dominant animals do best; there are, however, wide differences in success within any one class of bears. One top



male was observed during 1971 to catch 62 fish at a rate of 7.8 an hour, while a lower-ranking large male caught 195, but at a rate of only 1.5 an hour.

Observations made during the 1971 season revealed that large males averaged 3.5 fish per hour at the falls, while small males caught only 0.8 per hour. Large sows caught 3.3 fish per hour, small immature sows got 1.7. Sows with cubs caught 2.0 salmon for each hour of effort. These females were easily distracted from fishing when other bears showed up, for at such times defense of their young took precedence over fishing.

The bear concentration at McNeil River Falls ends in late August along with the chum salmon run. The bears then switch to a diet of vegetation or, more likely, move to streams that still have salmon.

The salmon that a bear catches in the summer are probably critical to its annual nutritional intake. Therefore, high rank and corresponding fishing success may pay off in the form of weight gain and subsequent winter survival. This ties in with the belief that social behavior is often a causal factor in the population dynamics of a species and that social intolerance caused by competition for a limited food supply may lower the birthrate, increase the death rate, or, in the case of bears, increase the number of animals dispersing to less favorable habitats.

With the hope of learning more about bear-human interactions, I have kept records of the signals that were used in encounters between the bears and my assistants or myself. I have found that a bear signals a human much the same way it signals another bear. Most frequently, it shows submission by running or walking away, but occasionally it may pick the other extreme and go into a stiff-legged, openmouthed, ears back charging display to seemingly test your mettle. I have been fortunate in that every display of this last type that I have seen has been a bluff.

The most important way for a human to signal peaceful intentions to a bear is to have the right attitude before entering its territory. The cardinal rule is to give the animal enough room; to crowd a bear is to invite an aggressive reaction on its part.

For those whose intentions are not peaceful, an increased awareness of the brown bear's rich and fascinating social behavior will hopefully make it a less desirable trophy. It is far easier to exterminate something that you don't understand than something that is analogous to your own behavior. Chimpanzee hunters are a far rarer breed than bear hunters.

For our convenience in destroying its habitat, and in making it a game animal, we have denied the brown bear the protection it needs. Perhaps as more people begin to enjoy, appreciate, and understand wildlife, such lamentable mistakes as the extermination of the brown bear from the American West will not happen elsewhere. Its future depends upon this. ■

The Cheyenne Experience

by Vine Deloria, Jr.

SEVEN ARROWS, by Hyemeyohsts Storm. *Harper & Row, $4.95; 371 pp., illus.*

For decades one had little choice when looking for books on the American Indian. Most books followed a standard format so dull and traditional that the subject appeared unimportant. A friendly white with an interest in Indians would contact a publisher and make arrangements for a book on the history of some tribe. He would devour the dozen or so books already written on the tribe, draft a good summary of the material, being careful not to be too obvious in using other people's words, and hand in his manuscript. Little new material was incorporated into the book, the viewpoint stayed the same, and only the book jacket changed.

Outside of a number of smaller paperbacks of limited distribution by Ruth Bronson Muskrat, Ella Deloria, and D'Arcy McNickle, few Indians had written books since the early decades of this century, when Charles Eastman, a Sioux physician, produced a series of books on his recollections of Indian culture. Other than these works, none of which became known to the general reading public, no books on American Indians by American Indians had ever been written.

In the early 1960s the first breakthrough occurred when Emerson Blackhorse Mitchell published *Miracle Hill,* a recounting of his experiences as a young Navaho trying to understand the white man's culture. Mitchell was just entering his teen years when the book was released and perhaps the novelty of a teen-ager writing a book overshadowed the fact that the book was an excellent presentation of a unique and difficult story.

The real breakthrough in American Indian literature came in 1968 when Stan Steiner published *The New Indians* with Harper and Row. The book was a chronicle of the rising Indian movement, particularly as it had been experienced by post-college Indians of the National Indian Youth Council and the National Congress of American Indians. *The New Indians* sold well in non-Indian circles and virtually exploded in Indian circles. It spoke to the countless frustrated Indian college students who were increasingly concerned that the social movements of the 1960s had passed Indians by. Alcatraz followed, and the movement was under way.

Almost immediately, publishers began beating the bushes for Indian authors, and Indians thought that the time had actually come for a presentation of their concerns to the reading public. Alas, the desire for income weighed heavier than the thirst for literature and despite N. Scott Momaday's *House Made of Dawn,* which won the Pulitzer Prize in 1969, the trend swept from books *by* American Indians to books *on* American Indians.

As the movement grew, the reading public latched on to Dee Brown's *Bury My Heart at Wounded Knee* and made it a phenomenal bestseller. McGraw-Hill, erasing the barriers between fiction and nonfiction, presented the thrilling *Memoirs of Chief Red Fox,* the story of an alleged Sioux chief whose supposed tribe had never heard of him and whose chief claim to Indian ancestry was his pitch as a sausage seller during the 1950s. Those publishers who had been caught short at the cash register promptly came forth with some hurried anthologies of great Indian speeches; and a maudlin collection of sentimental trivia followed, highlighted by T.C. McLuhan's *Touch the Earth,* with sepia pictures and Chief Joseph's surrender speech reprinted for the hundredth time.

Two books by Indians on current political problems, *The Tortured Americans* and *Custer Died for Your Sins,* only spurred readers to flee to the past glory and romance of Indians, rather than to consider their responsibility for the current depredations against Indians by their favorite senators, congressmen, and governors. Momaday's second book, *The Way to Rainy Mountain,* was fairly well received since it did not deal with contemporary problems but made a poetic presentation of past Kiowa history.

The problem in judging literature on American Indians, then, has been establishing the categories of what exactly constitutes a book on Indians. At the start we can discard the anthologies since they show a remarkable similarity, as if only a certain number of documents were ever available to the compilers. With the exception of *The Way,* by Stan Steiner and Shirley Hill Witt, the anthologies are merely the reshuffling of speeches taken out of obscure journals and reprinted periodically as Indians wax and wane in favor with the reading public. *The Way* is a collection of writings and sayings of young Indians as yet unpublished and displaying, in some cases, considerable talent.

Another category in Indian literature must surely consist of the standard tribal histories and traditional stories of the American Indian, generalized histories that follow the interpretive scheme of western conquest, ending, of course, in 1890. If one is only interested in what the people were doing in 1876 these books are all right. If one cares to examine the present state or location of the people, these books are dangerously misleading since they appear to arrive at the unanimous conclusion that the particular tribes vanished in 1891.

The final category must be books by American Indians covering some particular concern of the Indian community. A good number are political tracts involving contemporary problems. These are important books but lack the support of a unified Indian political force to give them impact. It was not, remember, until the Civil Rights movement heated up that James Baldwin became a philosopher in the eyes of white America.

Seven Arrows, it seems to me, begins a new and very important development in Indian literature. It is first a book that makes a statement without any reference to external buttressing evidence. That is to say, one need not have the foggiest idea of what Indians are like in order to

"Among the People, every person possessed a Shield of one kind or another. One of the most important things to understand about these Shields is that they were never intended to give physical protection in battle. . . . Sometimes they were made from the tough hides of bears or buffalo bulls, but more often they were covered with the soft skins of deer, antelope, coyote, otter, weasel, or even mice. They were then hung with eagle plumes, cedar pouches, tassels of animal fur, and many other things. They were also painted with various symbolic figures." Two symbolic shields designed by Hyemeyohsts Storm and painted by Karen Harris.

"Now there are Four Things . . . . They are the Wolf Stick, the Thunder Bow, the Pipe of Peace, and the Brother Arrows. Now there can be a Renewal."

understand the book. Consequently, the usual concepts by which books are judged are not available for analysis of *Seven Arrows.* It appears to be a novel in that it traces the Cheyennes over a period of years and often incorporates their friends, the Sioux, and neighbors, the Crow, into the story with such smooth transitions that one does not question where they came from and why they are present.

But to classify *Seven Arrows* solely as a novel would lead readers astray, for it lacks the rigid structure that defines the novel in Western European traditions. It has no definite starting and finishing points, and thus time, so important to Western man, appears in the Indian context as a relative, an extremely relative, determining force. One day we are in the past, the next day we are on the reservation in the early days, the following day we are apparently talking about modern times. Time, as such, is useful only to keep the non-Indian readers from losing their orientation with respect to the major themes of the book. The format, if we look at the sequence of the story, is solidly and traditionally Indian.

Within the general theme of the people's experiences we find a willingness—through the question and storytelling answers of the leading

characters of the Brotherhood of the Shield—to articulate the major archetypal themes of Indian communal existence. Thus, at the beginning of the book, when we are in the prereservation period, members of the camp bring their questions to the elders and receive the medicine stories concerning the meaning and origin of things. With the text rapidly shifting between happenings and explanations of the religious beliefs and doctrines, the reader comes to understand the importance of expanding religious conceptions of life as a growth phenomenon of a community.

Numerous characters dot the pages of the book but not as extraneous figures in a colossal, historical sense. Rather, each character illustrates the gradual shifting of sensitivity and outlook as it has been experienced by the community as a whole. Incidents of the story become departure points for bringing the events of daily life into a cosmic focus. We are told at the beginning that the Medicine Wheel and the Sun Dance teaching present a mirror in which everything is reflected. Characters thus merge and emerge as the reflections of the universe change through continued growth.

What we have in *Seven Arrows*, therefore, is a statement about the universe and an intense effort to illustrate how that statement validates itself in the continual reintegration of experiences of a community of people. The importance of this concept for theology and related social sciences is tremendous. Religion is conceived of and presented by Storm as a continuing presence of powers and the ways that these powers identify with and involve the people. When we consider that most other religious statements are concerned with proving historical facts, such as the Resurrection, the location of the Garden of Eden, or the reality of divinity in concrete terms of salvation or escape on an individual basis, the startling statements of *Seven Arrows* take on a deep meaning. For a world that is utterly convinced that divinity exists at its pleasure, the revelations of the book may draw skepticism and derision. But then all fundamentally different religious conceptions are initially rejected for their doctrinal

impossibility, only to be later accepted because they are meaningful in the collapse of doctrinal certainty.

One is tempted to compare *Seven Arrows* with the two books on Don Juan, which have proved so popular with young whites seeking the real substance behind Indian religious and communal ideas. *Seven Arrows* is solidly and triumphantly an Indian book. By comparison, *The Teachings of Don Juan* and *A Separate Reality* are peripherally Indian: that is, they have references to the Yaqui in them. But *Seven Arrows* is concerned with land and the centering of the universe, rivers, mountains, and other hard facts of Indian existence that are determining factors in the vast majority of Indian tribal religions.

One might conclude by mentioning the outstanding paintings and sepia pictures that dominate one's recollections of the book's impact. They are skillfully chosen so that when one is reading about the buffalo people he has a picture of the buffalo to see. Many times a picture often only previews the possibility that what is shown will somehow be confronted at some point in the text. If Marshall McLuhan is skillful in combining text and visual presentations, Hyemeyohsts Storm is equally adept at merging visual and textual presentations for maximum impact.

Scattered throughout the book are stark paintings of shields portraying the stories of the book. Some people have remarked that these pictures are hardly the rigid figures to be found on traditional paintings of religious themes by American Indians. It is this objection that indicates a misunderstanding of the book in a dreadful and total sense. *Seven Arrows* is not, like Peter Powell's *Sweet Medicine* (a book covering the same Cheyenne religion), an explanation of what the religion was or how it is practiced today. *Seven Arrows* is a religious statement, not a statement about religion, if the difference can be understood.

When one considers the nature of the Indian movement, the importance of this book appearing at this time is evident. Almost every Indian activist event has involved establishment of a particular Indian community at a particular place to do a particular job. The seizing of Alcatraz was an effort to establish a religious study center and ecological laboratory. Fort Lawton, in Seattle, was invaded by Indians seeking a cultural center for training Indians to be Indians. The activists have expressed in political deeds what Storm is saying in poetic-novel-teaching form.

Seven Arrows is thus totally political if politics can be severed from man's total experience and made a discipline or career. It is totally sociological if sociology can also be severed and made a cold and abstract subject matter. The presentation of this sense of totality without apologies to recorded data on Indian religions or to the critiques of purists, the simple statements of understanding—these attributes make *Seven Arrows* important and qualitatively distinct from everything else written on or by Indians with the exception of Neihardt's Black Elk material to which *Seven Arrows* has great and consistent affinity.

Hyemeyohsts Storm and Douglas Latimer of the Harper and Row Indian series are to be applauded for the publication of *Seven Arrows*. The book forces the field of Indian literature beyond simple explanations of gathered facts or recitation of cherished stereotypes, no matter how sympathetic. It presents a statement of integrity about the nature of man's existence in an Indian communal sense. Indian literature must take this statement seriously and pass beyond trivia to the issues of our existence.

Vine Deloria, Jr., is author of the books Custer Died for Your Sins *and* We Talk, You Listen.

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26—Arthur W. Galston
33-47—David Brill
48-59—Christopher Williams
61-64—Douglas Faulkner
66-73—Derek and Molly Stonorov
74-75—Robert Pollock
76-top, Ronald Hoham; bottom, John Marr
78—AMNH after Hardy
90-91—Derek and Molly Stonorov
94—AMNH
96-98—Courtesy of Harper & Row
104—Univ. of Toronto
106—Helmut Wimmer
Erratum: October 1972 issue, pp. 63-66—Herman Zwinger

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Suggested Additional Reading

ORGANIC FARMING ON TRIAL

NUTRITION AND THE SOIL. L.J. Picton. The Devin-Adair Company, Old Greenwich, 1949.

THE LIVING SOIL. E. Balfour. Faber and Faber, London, 1949.

EDUARDO THE HEALER

MOCHE: A PERUVIAN COASTAL COMMUNITY. J.P. Gillin. Greenwood Press, Inc., Westport, 1945.

FOLK PSYCHIATRY. C.A. Seguin. Chapter in WORLD BIENNIAL OF PSYCHIATRY AND PSYCHOTHERAPY, Vol. 1. S. Arieti, ed. Basic Books, Inc., Publishers, New York, 1970.

MAGIC, WITCHCRAFT AND CURING. J. Middleton, ed. Doubleday and Company, Inc., Garden City, 1967.

CRAFTSMEN OF NECESSITY

ARCHITECTURE WITHOUT ARCHITECTS. B. Rudofsky. Doubleday and Company, Inc., Garden City, 1964.

STONE SHELTERS. E. Allen. The M.I.T. Press, Cambridge, 1972.

NATIVE GENIUS AND ANONYMOUS ARCHITECTURE. S. Moholy-Nagy. Horizon Press, New York, 1957.

THE SUPERSENSITIVITY OF FISHES

FISH AND INVERTEBRATE CULTURE. S. Spotte. John Wiley and Sons, Inc., New York, 1970.

THE GOLDFISH. G.F. Hervey and J. Hems. Transatlantic Arts, Inc., Levittown, 1968.

EXOTIC AQUARIUM FISHES. W.T. Innes. E.P. Dutton and Company, Inc., New York, 1956.

PROTOCOL AT THE ANNUAL BROWN BEAR FISH FEAST

A NATURALIST IN ALASKA. A. Murie. The Devin-Adair Company, Old Greenwich, 1961.

THE BROWN BEARS OF MCNEIL RIVER. J.B. Faro. *Alaska Magazine*, October, 1971.

MAN AND THE GRIZZLY BEAR. S. Herrero. *BioScience*, November, 1970.

THE CANDY-COLORED, SNOW-FLAKED ALPINE BIOME

BIOLOGY OF MICROORGANISMS. T.D. Brock. Prentice-Hall, Inc., Englewood Cliffs, 1970.

THE FRESH WATER ALGAE OF THE UNITED STATES. G.M. Smith. McGraw-Hill Book Company, New York, 1950.

THE CRYOFLORA OF THE PACIFIC NORTHWEST. R. Garric. *American Journal of Botany*, January, 1965.

THE UNCERTAIN FUTURE OF THE TROPICS

THE CARELESS TECHNOLOGY. M.T. Farvar and J.P. Milton. Natural History Press, Garden City, 1972.

THE NORTHERN MYTH. B.R. Davidson. Cambridge University Press, New York, 1965.

FARMING SYSTEMS IN THE TROPICS. H. Ruthenberg. Clarendon Press, Oxford, 1971.

Death Throes of Hot Binarie

Hot, young, massive stars tend to blow up in what astronomers call supernova explosions. For a few weeks the star radiates the energy of a whole galaxy; then what is left, if anything, collapses in on itself to produce a superdense neutron star or a black hole.

Many of these hot stars are members of pairs, or binary systems. Tightly bound by gravitation, the stars in such a system orbit each other at speeds of 50 miles a second or more, although the system as a whole may be moving through space at no more than five miles a second. They are separated by much less than the distance from the earth to the sun.

When one of the stars suddenly loses its mass through a supernova explosion, however, the other is no longer gravitationally bound. It flies off in a straight line at the same speed with which it had been orbiting its former companion. We get the same effect by whirling a weight on a string around our heads at a high speed, then suddenly letting go. The weight flies off in a straight line. Stars moving like this are called runaway stars. They are detected by their anomalously high velocities, and are usually found moving away from associations of hot, massive stars.

Many such stars have been found. Since 1968 radio astronomers have also found many pulsars, the rapidly rotating neutron stars left by the supernova explosions. Nearly all the pulsars, too, are "runaways," moving through space at high speeds.

Because most pulsars do have a high space velocity, astronomers conclude that they were once part of binary star systems. None have been found still in orbit with a "normal" star, so it would appear that pulsars represent less than half of their own original mass: if they had retained half or more, they would have remained gravitationally bound to the normal star.

After one star in a pair has exploded, it will not be long, by astronomical standards, before the other does the same. The remnants of both should be pulsing neutron stars, with the most recently formed pulsar beeping faster than the older one. Two such cases have been tentatively identified. Just outside the Crab Nebula is a pulsar with a rate considerably slower than the pulsar at the center of the Crab. And in the southern sky an old pulsar is close to a young one in the constellation Vela.

We may now have our first example of a pulsar still gravitationally bound to a normal star. In the *Astrophysical Journal*, J. Richard Gott III of Princeton University Observatory offers his candidate, a seventh-magnitude runaway star about 1,100 light-years away whose unseen companion could well be the remnants of a supernova explosion.

Thus, for every runaway star we see, there probably is, or at least was, a pulsar. And the runaway stars themselves, like all hot, young, massive stars, are soon themselves to be supernovae and will subsequently collapse into either pulsars or black holes. In these stars, whose lives are speeded up compared to the cooler stars like our sun, we have a hint of the energy death of the universe: stars being formed, burning furiously for a while, exploding, and finally, their remnants slowing down and cooling until they become dark, shrunken, dead pulsars.

The bright star at bottom is a supernova, a star that blew up, in the southern constellation Centaurus. The explosion actually occurred 10 million years ago, but the light from it did not reach the earth until last May. The fuzzy patch above the supernova is the center of the galaxy to which it belongs. Last summer the supernova was brighter than its whole galaxy. This is the brightest supernova seen in 35 years, and one of the four brightest ever recorded.

by John P. Wiley, Jr.

More on Phobos Last May we published a close-up picture of potato-shaped Phobos, the larger of the two Martian moons, and lamented that it certainly did not look like an artificial satellite and that therefore the moons had lost some of their fascination. Now a Texas reader, C.J. Ransom, has pointed out that for another reason they may be still less interesting.

For about 25 years astronomers have believed that Phobos has been speeding up and moving closer to the surface of Mars, setting the stage for a spectacular crash in the next 10 to 20 million years. Ransom told us that recent work in England indicates that this may not be so.

A. T. Sinclair of the Royal Greenwich Observatory used 3,107 positions of Phobos and Deimos, the second, even smaller moon, in a study of their orbital motions. He found that the supposed acceleration of Phobos depended entirely on observations made at the oppositions of 1877, 1879, and 1881. When these are excluded, Phobos is found not to have speeded up at all and instead appears to be slightly slowing down.

Sinclair wrote in the *Monthly Notices* of the Royal Astronomical Society: "It would seem that the observations of the satellites are not sufficiently accurate to show [any acceleration] conclusively. But it looks very much like Phobos will be with us for a long time to come."

Report from Our Sister Planet The soil of Venus, at least in one spot, is very similar in composition to granitic rocks on earth; it resembles most closely terrestrial rocks that emerged in molten form from the earth's interior and then went through extensive modification.

This preliminary report on the first Venusian soil samples ever analyzed was released by the Soviet Union nearly two months after the Russian *Venus 8* soft-landed on our sister planet and transmitted data back for 50 minutes.

Similarities in composition were to be expected. The earth and Venus are nearly the same size, density, and distance from the sun, and most astronomers believe they formed out of the same materials at the same time. But the same chemical abundances can show up in different ways; much of the carbon that on earth is locked up in rocks is in the Venusian atmosphere in the form of carbon dioxide.

The Soviet capsule encountered high winds on the way down, and on the surface detected some sunlight that had penetrated the heavy cloud banks that perpetually enshroud Venus. The winds ranged from about 110 miles per hour when the capsule was 28 miles above the surface to less than 10 miles per hour when it was within 6 to 7 miles of the surface.

The heavily insulated capsule landed on the only part of the illuminated portion of the planet that was visible from earth at that time. Thus, it was able to be on the day side and still maintain direct radio contact with earth. Because Venus is closer to the sun than the earth is, and because spacecraft are usually launched when the planet is close to us as it swings between us and the sun, earlier landings have been made on the dark side. The Soviets have yet to release precise readings on the daylight, but they did say that "a certain portion of sunlight does penetrate to the surface so that there is a noticeable difference in illumination between the planet's night and day sides."

The United States, which definitely plans to land a capsule on Mars in 1976 or later, has tentative plans for such a landing on Venus. A year from now the United States will launch a spacecraft that will fly within 3,300 miles of Venus and then continue on to Mercury. Then in 1977 the U.S. may put a spacecraft in orbit around Venus, from which probes into the atmosphere and to the surface would be launched.

The Gentle Terrain of Mercury Radar observations of Mercury have revealed that this innermost planet is considerably less mountainous than either Mars or Venus. Topographic variations apparently do not exceed a half-mile or so. On a finer scale, however, scattering of the radar signal suggests that the surface itself is rougher than that of either Mars or Venus and most resembles the moon. This surface roughness varies from one part of the planet to another.

These findings from the Haystack Radio Observatory in Massachusetts were reported in the *Astronomical Journal* by R.P. Ingalls and L.P. Rainville.

Radar is a crude method for mapping a planet: it cannot resolve any topographical feature less than 25 miles across. But because Mercury is far away, so much smaller than even Mars, and always very close to the sun as seen from earth, radar gives us information we cannot get in any other way.

Celestial Events

by Thomas D. Nicholson

The Moon The moon is gibbous, appearing in the evening sky from sunset until well past midnight from mid-November until full moon occurs on November 20. After the 20th the moon begins to wane. Rising later each night after sundown, it remains in the sky until dawn. Last-quarter moon occurs on November 27, after which the moon becomes a waning crescent in the dawn sky. After new moon on December 5, the moon again enters the evening sky, appearing as a crescent in the west a few nights after, and reaching first-quarter on December 13.

Stars and Planets Although the stars of the Summer Triangle—Altair, Deneb, and Vega—are still visible low in the west in the early evening, the sky before midnight is now dominated by the autumn constellations, from high overhead into the west, and by the bright winter stars, which are rising in the east.

The evening sky still features Jupiter, but the bright planet, among the stars of Sagittarius, sets only a little more than an hour after it becomes visible. Shortly after sunset, however, Saturn rises to the north of east, among the stars of Taurus. Saturn is still in the sky at dawn this autumn, having moved with the stars of Taurus into the west.

Before sunrise Saturn is joined by Venus and Mars. Venus, the brighter of the two, moves from right to left to catch and pass Mars on December 3, then separates from Mars to the left. Mercury can also be seen as a morning star, below and to the left of Venus, for about a week before and after the westerly elongation of Mercury on December 14. This is a favorable morning elongation for Mercury; the planet will be about 15 degrees above the southeastern horizon at sunrise.

Meteors One of the most famous of all meteor showers, the Leonids, reaches maximum on November 16, with no moonlight during after-midnight hours. During the nineteenth century, and then again in 1966, this stream of particles produced great storms of meteors in parts of the world. During off years, such as this, the observer can expect to see only about 10 to 15 meteors per hour, but many of these may be exceptionally bright.

November 20: Perigee coincides with full moon. Expect perigee spring tides, ranging 60 to 80 percent above normal.

November 21-22: Saturn and the moon rise close together in the early evening. The moon moves closer to the planet until conjunction at 2:00 A.M., EST, on the 22nd, then separates to the left.

November 25: Mercury, at inferior conjunction, enters the morning sky.

December 3: The moon is in conjunction with Venus and Mars in the early morning, and the two planets are in conjunction with one another in the early evening. This morning at dawn, the crescent moon is below and to the right of the bright planet Venus; Mars, dim and red, is between the two.

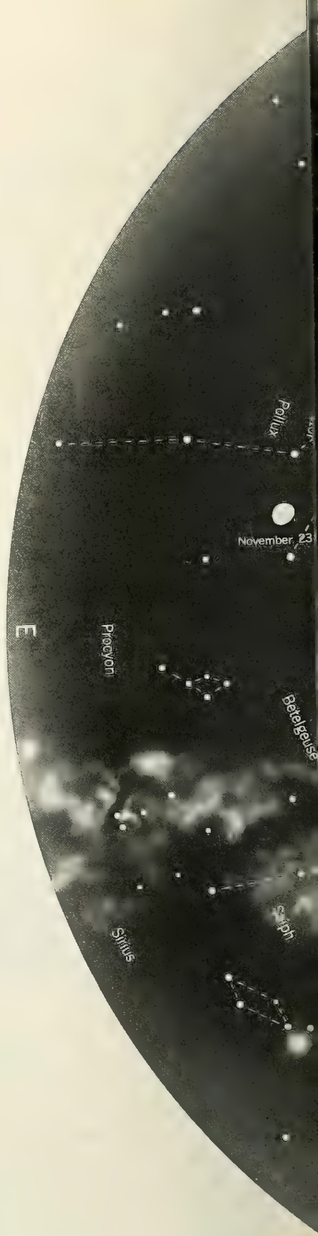
December 4: Look for Mercury above and to the left of the rising crescent moon this morning. Venus is above and to the right.

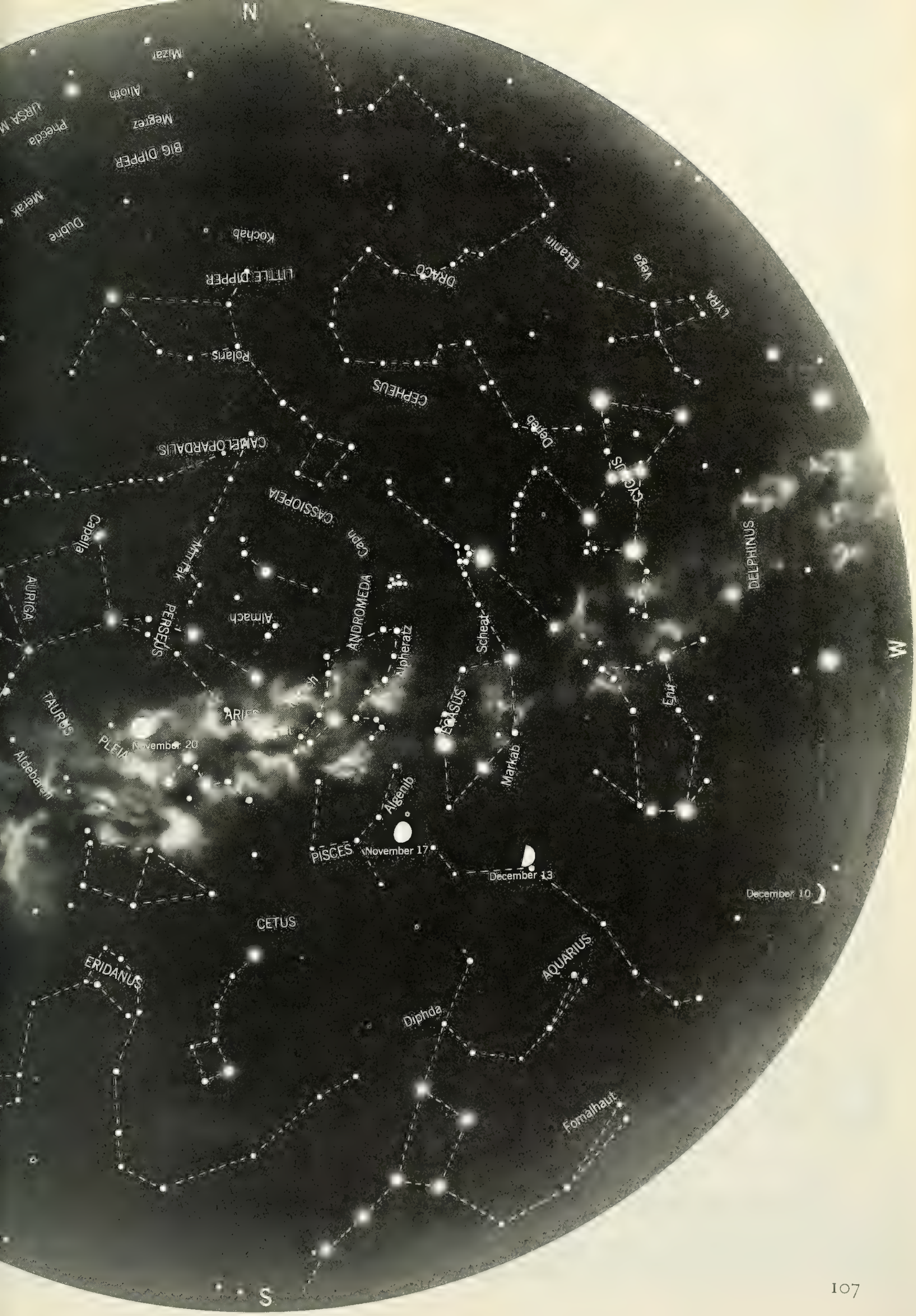
December 7-8: Jupiter is near the crescent moon on these evenings.

December 8: Saturn is at opposition.

December 13: The Geminid meteor shower reaches maximum.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:15 P.M. on November 15; 9:15 P.M. on November 30; and 8:20 P.M. on December 15; but it can be used for about an hour before and after those times.

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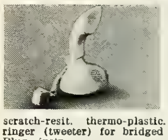

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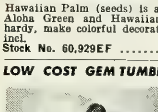

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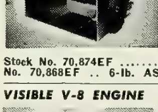

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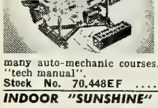

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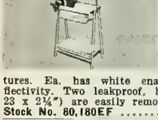

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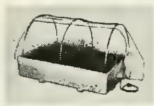

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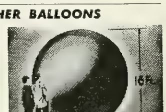

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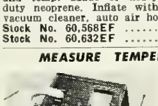

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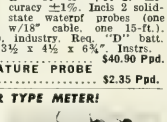

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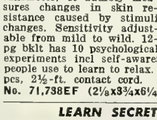

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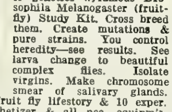

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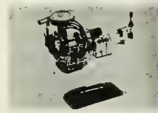

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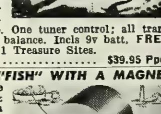

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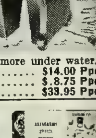

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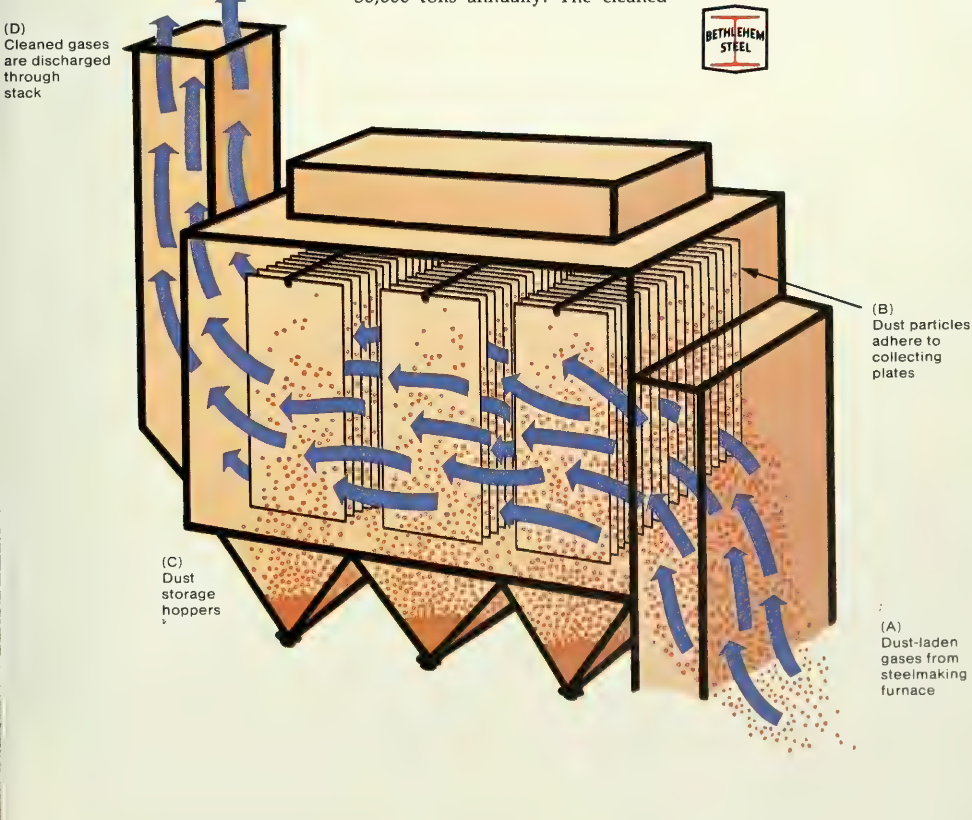

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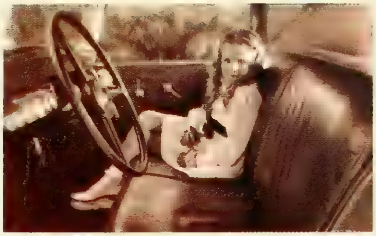

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NATURAL HISTORY

DECEMBER 1972 • $1


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The new 1973 Thunderbird pictured above also includes as standard equipment new energy-absorbing bumpers with bumper guards, left-hand remote control mirror and white sidewalls. Other equipment shown is optional.

NATURAL HISTORY

Incorporating Nature Magazine
Vol. LXXXI, No. 10
December 1972

The American Museum of Natural History
Gardner D. Stout, President
Thomas D. Nicholson, Director

COVER: *"Mud-browned Elephants" is from a dual volume on Africa by Peter Matthiessen and Eliot Porter, reviewed on page 92.*

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Authors

The renewed attention currently being directed to the Nacirema culture, a dynamic society whose rapid disappearance has baffled archeologists for years, prompted **Neil B. Thompson** to review the field work conducted since 1956.

Neil B. Thompson

His interpretations, valuable for their historic insights, could well serve as guides to some contemporary social problems. Thompson is director of the Program of American Studies at St. Cloud State College; his next research project will concern a romantic figure from the vanished empire, the Plains soldier.

The life of George Catlin, painter of Indians, was a natural subject for **Phillip Drennon Thomas**, a professor of history at Wichita State University who has long studied Indian history. He has traveled throughout the West in search of Indian artifacts and lore. After completion of a book-length study of the nineteenth-century explorer and linguist Sir Richard Burton, he will begin an analysis of the importance of wild

Phillip Drennon Thomas

animals in the economic history of America. Thomas is the author of "Nights in Pliny's Garden," which was published in the March, 1972, issue.

Barbara R. and **Michael H. MacRoberts** began studying the acorn woodpecker in 1966, but the project was curtailed when they both undertook graduate work in anthropology. They managed six more months of field observations in 1968 before joining Niko Tinbergen's Animal Behaviour Group at the University of Oxford in England. The MacRobertses returned to the United

Barbara R. and Michael H. MacRoberts

States last year to complete their woodpecker research, which is centered at the Frances Simes Hastings Natural History Reservation in the Carmel Valley of California. They plan to spend two more years investigating the behavior and ecology of the birds in this area. Michael MacRoberts is a visiting scholar at the Museum of Vertebrate Zoology of the University of California at Berkeley. This husband and wife research team wrote "The Apes of Gibraltar" in the August-September, 1971, issue of *Natural History*.

Following a 400-million-year-old trail from New York to Michigan, **Niles Eldredge** has pieced together the evolution and migration of a Devonian trilobite. His conclusions present a divergent view of the evolution of a species. An assistant curator of invertebrate paleontology at The

Niles Eldredge

American Museum of Natural History, Eldredge is also adjunct professor of biology at the City University of New York and adjunct assistant professor of geology at Columbia University. His next research project will be a study of the early evolution of the horseshoe crab.

Michelle Eldredge, coauthor of "A Trilobite Odyssey," assisted in the collection and analysis of trilobite fossils on all the field trips undertaken by her husband during the past five years. She has a master's degree in English from Columbia University, but paleontology has become her primary avocation. She also plans to make an ecological study of a pond in the Adirondack Mountains of New York, where the Eldredges spend a part of every summer.

Michelle Eldredge

As director of a smallpox and measles eradication program in Mali during the late 1960s, **Pascal James Imperato** found it necessary to make a comprehensive study of the social organization and migratory movements of the Peul and Bozo nomads. The results provided a clear picture of a transient, but not haphazard, society. Imperato, director of the Bureau of Infectious Disease Control and principal epidemiologist of the City of New York Department of Health, received a master's degree in public health and tropical medicine from Tulane University after completing a residency in internal medicine. He has done extensive field work in Africa, including research into the witchcraft and traditional medicine practiced by the Luo of Tanzania and skin sensitivity among various tribes in west Africa.

Pascal James Imperato

Convinced by the continuing reports of sightings and tracks that the Tasmanian tiger is not extinct, **Jeremy Griffith** began a thorough search for the marsupial predator six years ago. Probing the remote Tasmanian bush with electronic camera monitors and assisted by a team of volunteers, he hopes to succeed where previous expeditions have failed. Ronald Strahan, director of the Taronga Zoological Park in Sydney, Australia, writes of Griffith's ability to continue the hunt despite a lack of funds that "he has learned how to live off of the smell of an oil rag." Griffith, who earned a B.S. in zoology from the University of Sydney, hopes to pursue a career in wildlife conservation when the search for the Tasmanian tiger is concluded.

Jeremy Griffith

Letters

The Pig Riddle

In the October issue of *Natural History*, Marvin Harris puts forth some ideas about why we have dietary laws against pork. While I found his ideas logical and interesting, I also was forced to think back to the days when I lived for two and a half years in an Aymara village on the Bolivian Altiplano. In that area, life is also very difficult due to the lack of rain and poor growing conditions. Meat is scarce and the Aymara people depend upon sheep and llama for their occasional source of meat. However, almost every family in my village had two or three pigs. I never saw pork eaten in the village during the entire two and a half years I was there.

When I realized that there was a strong aversion to eating pork among the Aymara, I started an informal study. In the larger Spanish cities and areas where Mestizo families live, pork is indeed popular, and in the marketplaces every corner seems to have a lady making *chicharon* (a snack made from fried pork skin). In the larger towns, the pigs are fed table scraps, kitchen scraps, and since until recently the toilet consisted of a small patio in back of the house, the pigs used to clean that out too. Thus the pig was a great factor in public hygiene.

Out in the rural Aymara villages, where there are no toilet facilities whatsoever, the pigs have a field day gobbling up the human excrement. (One time, on a trip to a different village, I ducked behind a secluded stone wall and before I could finish, three pigs appeared and I had to fight them off with stones!) When I asked the Aymara why they sold all the pork to the people in the city, they replied, "Knowing what a pig eats, would you eat a pig?" The general thought seemed to be that if the city people liked to eat pork, the Aymara people would be glad to raise the animals and sell them—but they almost looked down their noses at anyone who would eat such a dirty animal.

THOMAS R. BURROW, JR.
New York, New York

In the many years I have read your magazine I have never before encountered such an inexcusable ignorant, poorly analyzed collection of pseudoscientific claptrap as Marvin Harris's article "Riddle of the Pig."

AARON S. CITRON
Flushing, New York

Professor Marvin Harris's article "Riddle of the Pig" appears to be a well-studied and well-observed thesis on an important domestic farm animal, and seems a logical solution to an old enigma.

There is little doubt that the porcine family is the most difficult animal raised on farms and ecologically speaking, doubtless man's near competitor of food. Actually, though appearing gross and tough, the pig is probably the most delicate farm animal, especially in warm and hot climes.

WOLF A. LEDERER
Tampa, Florida

Generation Gap

In the opening paragraph of your very poetic article, "Above the Treeline" (October, 1972), by Zwinger and Willard, the simile "foothills, as rough and muted as a torn blotter" was used. We set to wondering if younger readers would appreciate this or were even familiar with untorn blotters. As a result, we inquired of our children, all of school age, if they knew what a blotter was. Here are their replies:

Mike, age 20, college junior: "It's a desk cover."

Karen, age 18, college freshman: didn't know.

Pat, age 17, high school senior: didn't know.

This Christmas, make a Perseverance Pie. It takes a wee dram of Grant's 8® Scotch. And Auntie Fiona's recipe. (Send for it.)

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Christmas hasn't changed much in our family. Four generations later, we watch over the family Scotch—drop by drop—for eight full years. Our distillery is still Grant owned and Grant operated with the kind of dedication Auntie Fiona would be pleased with. And we still celebrate every year with her Christmas pie.

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Grant's 8® Scotch: share our family secret.

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Rita, age 17, high school senior: defined it adequately.

Libby, age 12, 7th grade: "I know! It's something that holds ink, like a bottle."

Tommy, age 8, 3rd grade: "A what?"

Apparently, a facet of our generation gap springs from vocabulary change as a reflection of advancement in technology.

Shirley A. Hammel
John M. Corliss
Baltimore, Maryland

A Vanishing Sound?

Because last year you gave away a recording, "The Language and Music of the Wolves," along with a membership, I thought that you might be interested in knowing that the government of Quebec has launched a new extermination program for wolves, which includes hunting, traps, and poison bait. Perhaps someday the only way to identify a wolf will be through recordings such as yours or from stuffed specimens.

Katherine Raynor
New York, New York

Sexual Bias

I perceive a sexual bias in "Conception and Contraception" (August-September). After listing the harmful side effects of the pill—blood-clotting, the possibility of causing cancer with long-term use, migraine headaches—and after noting the many alternate types and dosages that have been developed to control these side effects, several oral contraceptives for men are mentioned—and dismissed.

Two are dismissed for unspecified "toxic effects" (thromboembolism and cancer sound pretty toxic to me) and one because males taking it would have to give up drinking. I can't help wondering if these pills have been rejected because most researchers are men and willing to take less risks with their own bodies.

I, for one, would gladly give up what little drinking I do to share the risk of contraception with my wife. I can only hope that I read the article wrong and that research in this area is proceeding on a reasonable scale.

Stan Davis
Greene, Maine


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Photographer: David Hamilton Camera: Minolta SR-T 101

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Minolta

The Mysterious Fall of Nacirema

This vigorous culture's obsession with altering its landscapes and waterways may have caused its own death

by Neil B. Thompson

The revival of concern in the recently extinct culture of the Nacirema is, to say the least, most interesting, and perhaps reflects an increasing state of concern for our own society. (Aspects of the Nacirema culture were first described by Horace Miner in "Body Ritual Among the Nacirema," *American Anthropologist* (1956) 58:503–507.) The use of a multidisciplined approach in deciphering this puzzling culture is gratifying, for it is only by bringing all our methodological techniques to bear on the fragments of evidence in our possession that we will be able to rationally study and understand the history of this apparently vigorous but short-lived culture.

Through exploratory digs by our archeological expeditions, we are able to say with some confidence that the Nacirema were the dominant group in the complex of North American cultures. Although the Nacirema left a large number of documents, our linguists have been unable to decipher any more than a few scattered fragments of the Nacirema language. Eventually, with the complete translation of these documents, we will undoubtedly learn a great deal about the reasons for the sudden disappearance of what, from the physical evidence, must have been an explosive and expansive culture. For the present, however, we must rely upon the physical evidence we have uncovered and analyzed in order to draw any conclusions concerning its extinction.

When we examine the area occupied by these people in a single overview, it is immediately apparent that the Nacirema considered it of primary importance to completely remake the environment of the lands they occupied. On studying the fringes of their territory, particularly their penetration of the Cree cultural area to the north, one is struck by the energy that they expended on this task. Trees, if in large enough numbers and size to influence the appearance of the landscape, were removed. In treeless regions, hills were leveled and large holes were dug and partially filled with water. In a few areas the Nacirema imported structural steel with which they erected tall, sculpturesque towers. Some of these towers were arranged in series, making long lines that extended beyond the horizon, and were linked by several cables running through the air. Others, particularly in the northern fringe area, were erected in no discernible geometric pattern and were connected by hollow pipes laid on the surface of the earth.

When one views areas normally considered to be within their cultural suzerainty, one sees evidence of similar activity. Most trees were removed. In some areas, however, trees were replanted or areas were allowed to reforest themselves without assistance. Apparently, the fetish against trees went by fits and starts, for the Nacirema would sometimes move into a reforested area and again remove the trees.

Most of the land, however, was kept clear of trees and was sowed each year with a limited variety of plants. Esthetic considerations must have led to the cultivation of plants poisonous to human life because, while the products of the

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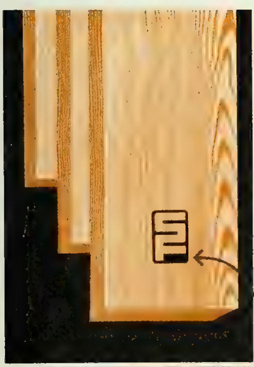

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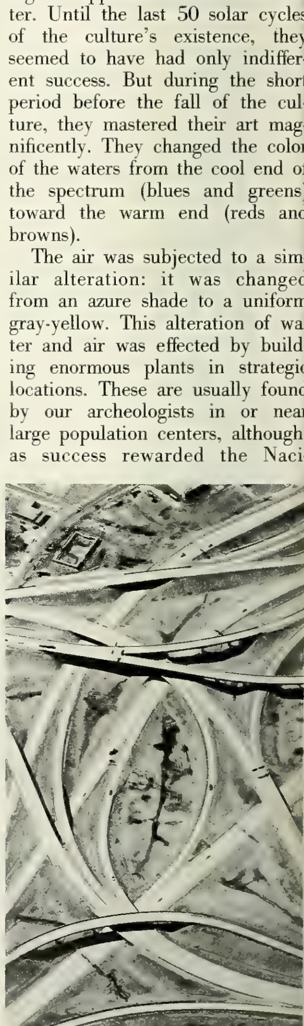
cropland were sometimes used as food, few were consumed without first being subjected to long periods of complicated processing. Purifying chemicals, which radically changed the appearance and the specific weights of the seeds or fibers, were added. These purification rituals were seldom performed in the living quarters, but rather in a series of large temple-like buildings devoted to this purpose. A vast hierarchy of priests dressed in white (a symbol of purity) devoted their lives to this liturgy. Members of another group, the powerful ssenisub community (whose position will be explained later), constantly examined the efforts of the first group and, if they approved, would affix to the finished product one of several stamps, such as "ADSU" or "Doog Gnipeekesouh." Still a third group, the repeekkoobs, accepted and recorded on permanent memorial rolls the gifts of the general population to their priestly order.

On a more limited territorial basis, the Nacirema spent great time and energy constructing narrow ribbons, called steerts, across the landscape. Some steerts were arranged in connected patterns, and in regions with a great concentration of people, the patterns, when viewed from the air, increased in size and became more elaborate. Other ribbons did not follow any particular pattern but aimlessly pushed from one population center to another. In general, their primary function seems to have been to geometricize the landscape into units that could be manipulated by a few men. The steerts also served as environmental dividers; persons of a lower caste lived within the boundaries of defined areas while those of the upper caste were free to live where they chose. Exploratory digs have shown that the quality of life in the different areas varied from very luxurious to poverty stricken. The various areas were generically referred to as ottehgs.

The task of completely altering the appearance of the environment to fit the Nacirema's ideology was given such high priority that the ssenisub community completely controlled the amassing of resources, manpower, and intelligence for this purpose. This group, whose rank bordered on that of a nonregimented priestly caste, lived in areas that were often guarded by electronic systems. There is no evidence to suggest that any restraints—moral, sociological, or engineering—were placed on their self-determined enterprises.

For a period of about 300 solar cycles (a determination made on the basis of carbon-dating studies), the Nacirema devoted a major part of their effort to the special environmental problem of changing the appearance of air and water. Until the last 50 solar cycles of the culture's existence, they seemed to have had only indifferent success. But during the short period before the fall of the culture, they mastered their art magnificently. They changed the color of the waters from the cool end of the spectrum (blues and greens) toward the warm end (reds and browns).

The air was subjected to a similar alteration: it was changed from an azure shade to a uniform gray-yellow. This alteration of water and air was effected by building enormous plants in strategic locations. These are usually found by our archeologists in or near large population centers, although, as success rewarded the Naci-



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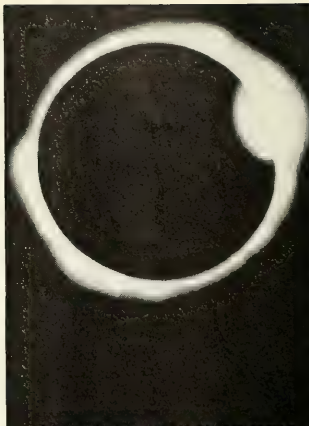
rema's efforts, they seem to have built smaller plants in outlying areas where environmental changes had not yet been effected. These plants constantly produced a variety of reagents, each appropriate to its locale, which were then pumped into the rivers and lakes or released into the atmosphere in the form of hot gases. The problem of disposing of the many by-products of this process was solved by distributing them among the general population, which retained them as venerated or decorative objects in their living quarters for a short time, then discarded them in the huge middens that were established near every population center.

In regions where colder temperatures apparently prevented the reagents from changing the color of the water sufficiently, the Naci-



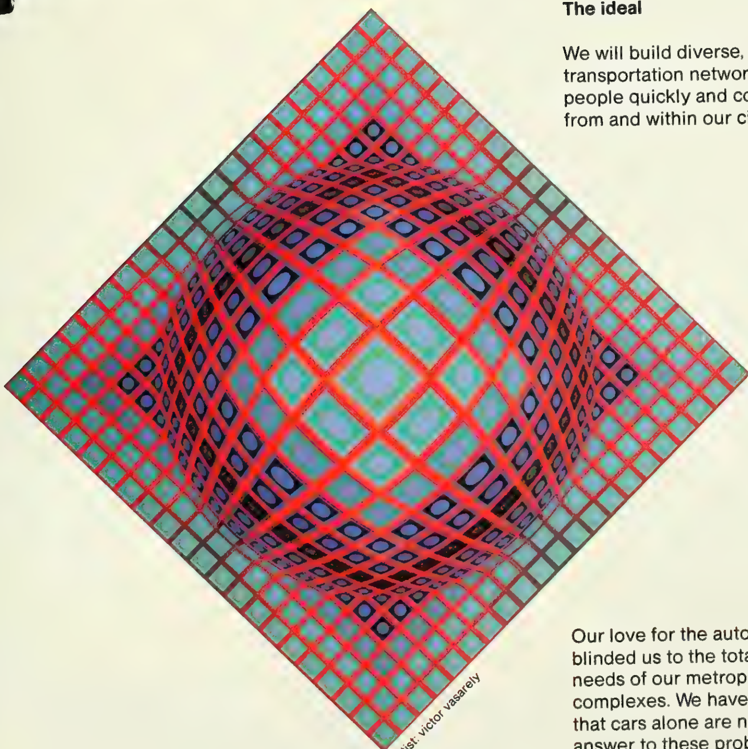
rema, near the end of their cultural explosion, built special plants that economically raised the water temperature to an acceptable level for the desired chemical reaction.

The idea of a man-made environment was so pervasive that in some areas, notably in the provinces called Ainrofilac and Anaisiuol, the Nacirema even tried to alter the appearance of the ocean currents. In these regions they erected steel sculptures in the sea itself and through them released a black and slick substance, which stained the waters and the beaches. This experiment, however, was relatively unsuccessful since the stains were not permanent and the Nacirema apparently never mastered a technique for constantly supplying the reagent.

Early research has disclosed the importance of ritualistic observance among the Nacirema. In support of these observations, we should note the presence of the quasi-religious Elibomotua Cult, which sought to create an intense sense of individual involvement in the community effort to completely control the environment. This pervasive cult was devoted to the creation of an artistic symbol for a man-made environmental system.

The high esteem of the cult is demonstrated by the fact that near every population center, when not disturbed by the accumulation of debris, archeologists have found large and orderly collections of the Elibomotua Cult symbol. The vast number of these collections has given us the opportunity to reconstruct with considerable confidence the principal ideas of the cult. The newest symbols seem to have nearly approached the ultimate of the Nacirema's cultural ideal. Their colors, material, and size suggest an enclosed mobile device that corresponds to no color or shape found in nature, although some authorities suggest that, at some early time in the development, the egg may have been the model. The device was provided with its own climate control system as well as a system that screened out many of the shorter rays of the light spectrum.

Continued on page 80


artist: victor vasarely

Bah, Humbug!

All the calculators being given this Christmas might well be used to figure out the costs and obligations of gift giving

The distinguished anthropologist S. K. Lauss of the University of Thule was in town recently, doing some Christmas shopping. I invited him to the Faculty Club to see what I could learn about his latest Arctic research.

"Apropos of Christmas shopping," he said, "have you ever heard the Eskimo expression: 'Gifts make slaves, just as whips make dogs'?"

"Interesting," I said. "But that can't be an aboriginal proverb. How could they have known about Christmas and Macy's?"

"They didn't," he replied, adding, "they never had to worry about getting whipped by salespeople."

"Or getting crushed by shoppers," I said.

"Right," he declared. "Or the wage slavery of consumerism."

"Or debt slavery to a bank or loan company," I added.

"Precisely, and for the same reason. They had never even heard of Master Charge. Don't forget, people were exchanging gifts thousands of years before Christ, before there was money or prices or interest."

"So they must have been down on gifts for some reason intrinsic to the gift-giving process itself."

"You're beginning to see the light," he said.

Recalling the French anthropologist Marcel Mauss's turn-of-the-century book, *The Gift*, I said, "According to Mauss, there's an inborn human compulsion to reciprocate gifts."

Lauss picked up the thread: "And Lévi-Strauss, who was Mauss's star pupil, has been trying to explain everything in terms of what he calls the 'most valuable gift of all—woman.' "

"A stroke of genius," I said. "What Frenchman could resist such a theory. No wonder he's the reigning French intellectual."

"Well, both Mauss and Strauss were wrong," said Lauss. "Gift giving and reciprocity are not the same thing. Gift giving is a form of reciprocity. But there are other ways to reciprocate."

"What do you mean by reciprocity?" I challenged.

"Reciprocity is the most important method of exchanging goods and services in small egalitarian communities, such as those in which the Eskimo live," he began. "Reciprocal exchanges are those in which the parties to the exchange never specify precisely what return is expected or when the return is to take place. When Eskimo reciprocity is at full strength, it looks to the observer as if valuables are merely being shared or taken without any obligation to provide equity or restoration."

Fearing that I was about to be swamped by Lauss's inexhaustible knowledge of Arctic cultures, I interrupted, "Give me an example from some other region."

"Robert Dentan makes the point beautifully for the Semai of Malaya. The Semai give and take portions of slain animals without any overt display of largesse on the part of the giver or of gratitude on the part of the taker. Even to say 'thank you' is a *faux pas* among the Semai, for it indicates that you are making mental calculations about how much you are getting. This implies that you are the kind of person who thinks it is unusual to be generous. Of course, each hunter eventually reciprocates to the best of his ability. That's reciprocity, but it's not gift giving."

"Thank you," I said.

"Never mind," he retorted. "Take my generosity for granted."

"Okay, how about another example?"

"Richard Lee's description of Bushmen. They're always belittling their own success as hunters. Anyone who starts to call attention to how good he is gets the cold shoulder. When a man brings down an enormous kudu that he can't carry back to camp, he goes home and smokes his pipe for a while. Sooner or later, someone asks him if he had any luck. The hunter then replies that he has caught a small, worthless kudu, so small and worthless that if he were not such a weakling, he would have carried it back to camp. When they hear this, the whole camp goes out to help him because the hunter is asking them

to do him the favor of accepting his food. That's reciprocity, not gift giving."

"I can see that," I said. "But now I don't see why you persist in calling it an exchange. It seems all giving away, with nothing coming back."

"On the contrary, there is a definite underlying expectation of some sort of return. One party can continue to take from the other for months or years without embarrassing the taker or annoying the giver. Nevertheless, there are unstated limits beyond which the relationship begins to deteriorate. If the balance gets too far out of line, the freeloader will eventually acquire a reputation as an antisocial deviant. If misfortune strikes the community, he is likely to be the first one accused of practicing witchcraft. No girl will marry him, and the other hunters shun his companionship.

"But there may never be a direct tie-up between this punishment and the unbalanced reciprocity. People prefer to think of such deviants as bewitched, rather than as ungrateful. Under no circumstances will they admit that they owe each other anything simply because one has given something of value to the other."

"Well," I admitted, "you've explained the difference between reciprocity and gift giving. Now tell me why the Eskimo are down on gift giving."

"Get me another frozen daiquiri," said Lauss, "and I'll tell you."

When I returned, Lauss resumed: "Gift giving is a degenerate and historically self-destructive form of reciprocity. On the one hand, in the true spirit of reciprocity, gift giving is not supposed to establish any obligations for exchange. But at the same time, gift giving happens to violate the basic etiquette of reciprocal exchange by calling attention to one's generosity. So, despite assurances that gifts are not meant to be reciprocated, the pressure to reciprocate is much greater than in normal forms of reciprocal exchange. If the gift receiver wants to avoid feeling inferior and protect his reputation in the community, he must exert himself to provide a return gift. So egalitarian

peoples are afraid of gifts. Gift giving tends to subvert the relationships based on purer forms of reciprocity. Gifts are like whips because failure to provide a return gift may result in permanently asymmetrical relationships."

Looking at me sharply, Lauss continued, "Didn't you yourself recently suggest that social classes evolved out of the increasing centralization of asymmetrical redistributive networks?"

I was about to thank him for reading my latest article when he cut me off with a scowl. "Would you like to hear how my analysis applies to Christmas?" he asked.

"Sure," I said.

"You won't be offended?" he insisted.

"Of course not. I'm not ethnocentric."

"The contradictions of gift giving are nowhere more evident than in your culture at Christmas time. Aside from all the other hazards and penalties of your national lust for consumer goods, gift giving at this time of year is a terrible threat to one's sanity. Everybody has to pretend that he wants to give away valuable items without expectation of equivalent items or anything at all in return.

"So the first rule of Christmas gift giving is that all price tags and sales slips must be removed from the gifts. This proves that the giver doesn't want the receiver even to think about the possibility of a return gift of equal value. But everybody knows that Christmas shoppers are experts at judging prices. So removal of price tags and sales slips never prevents anybody from accurately guessing the price of the items.

"The next routine requirement of the Christmas shopper," he went on, "is to clearly identify the item as a gift. It must not be confused with ordinary items in reciprocal exchange. This is done in two steps: the item is gift wrapped and the giver puts his name on a card that is tied or glued to the package. Gift wrapping by means of special brightly colored or shiny paper, ribbons, and plastic baubles draws attention to the gift, and identifies it as a significant act of generosity. The name card suggests to whom one should be grateful until the

act is reciprocated. Remember that when a Semai or a Bushman wants to provide valuables for his campmates, he doesn't begin by making a big fuss over it."

"Yes. Go on," I said, beginning to feel uncomfortable.

"As in true reciprocity, failure to match the value of a Christmas gift for a short time need cause no embarrassment. But a persistent imbalance, either above or below the actual price, will eventually lead to corrective action. Either the party on the high side lowers his desire to give, or the party on the low side raises his. Some of my informants have told me that close relatives and friends attempt to avoid this sort of unpleasantness by calling each other and agreeing beforehand on what kind of present each will give the other. Apparently, they may even indicate brand preferences. These items, however, can scarcely be called gifts, since the mode of exchange is closer to barter than to reciprocity.

"With certain revealing exceptions, persistent failure to reciprocate a Christmas gift will sooner or later result in getting oneself scratched off the gift giver's list. The exceptions are garbage men, janitors, secretaries, and children, all of whom your countrymen would like to treat as slaves, which is precisely what the Eskimo were afraid of."

"Wait a minute, Professor Lauss." I found myself quite agitated. "If you're so down on Christmas gift giving, how come you're in New York to do your Christmas shopping?"

Laying his finger to one side of his nose and winking as he quickly rose from the table, he answered, "I consider all forms of exchange, including reciprocity, inappropriate to the true spirit of Christmas.

"I'm never bothered with the foolishness of exchange because no one can ever find me to give me anything in return. You see, I just like to give things away."

And before I could say what I was going to give him for Christmas, he sprang out the door and into a taxi.

Columnist Marvin Harris teaches anthropology at Columbia University.

Plants Have a Few Tricks, Too

They cannot run and they cannot fight, but plants have evolved a variety of ways to survive

All creatures living in the wild are subject to attack by predators, and their survival as a species depends in large measure on their success in fending off such attacks. Animals have many obvious self-defense mechanisms. Some, for example, hide from enemies by merging into the landscape so that it is difficult to see them; others hide by deliberately popping into a hole or under a rock. Because of their speed, some creatures outrun potential predators, while others outlast them by superior stamina during a long pursuit. A cornered or alarmed animal can ward off an enemy by obnoxious odors, gestures, or noises, and in a pinch can stand and fight off an attacker. Even when faced with a microscopic invader, such as a bacterium, a fungus, or a foreign protein of any kind, many animals can react with a variety of defenses, including ingestion of the attacker by special mobile body cells or the formation of specific antibodies that couple with the invading protein or cell and render it harmless.

Plants, by contrast, seem at first sight to be relatively defenseless against attack, but a closer look reveals that they do have some mechanisms for warding off other organisms. For the most part, they are incapable of sufficiently rapid motion to do damage to an animal, although the insect-trapping devices of the sundew and of Venus's-flytrap have been widely popularized. Upon mechanical stimulation the leaves of the sensitive plant will rapidly fold, which is said to protect the plant against foraging animals. Thus, botanical humor has it that a goat entering a patch of wild *Mimosa pudica* would starve to death, because the plant's sudden folding of its leaves after jostling would make it seem unavailable for foraging. I personally doubt whether such an obvious ploy would deter an omnivorous goat.

Another kind of movement results from the tactile sensitivity and coiling growth of tendrils and other climbing organs; this permits some vines to grow over trees and, as in the case of the strangler fig, to completely kill the more upright host. The tree can do nothing to escape the ever tightening clutches of its unwanted epiphyte.

Most successful plant defenses are exerted against insects and microbes. It is well known, for example, that among closely related varieties or species of plants, some

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are eaten by insects while others are not, and that some are susceptible to a disease while others are not. In such cases the differences between the related plants are often a clue to their defense mechanisms. Protection may be rather mechanical; some leaves are very leathery in texture and are covered on both surfaces by a waxy cuticle or a thick, cushiony tuft of matted hairs. Such structural modifications of the leaf's surface repel some insect predators much as thorns repel some animals.

Other defense mechanisms are more chemical. For example, many wild plants contain bitter-tasting chemicals like alkaloids, tannins, or simple phenols, whose value to the plant is not well defined. Because of a general belief that everything in a wild creature must have some function (or else it would have been selected against and eliminated during the course of evolution), it has been suggested that these materials may discourage insects and large animals from eating the plant. Similarly, pungent, volatile materials like those of the onion and mustard are said to repel some insects at a distance, before they even get to the plant.

In some instances plant pathologists have been able to draw correlations between a plant's content of certain chemical components, such as the phenols, and its resistance to fungal diseases. Phenols are, after all, well-known germicidal materials; the carbolic acid so easily smelled in hospital corridors is phenol itself. If effective against external microbes, why not against internal ones as well?

But there are some difficulties with this theory. Why don't the phenols kill the plant itself? The answer may be that the phenols, tannins, and other germicidal materials of plants are found in vacuoles, separated from the living part of the cell by a membrane through which they cannot pass. They do not, therefore, act to repel or kill an invader unless the cell is first attacked in such a way as to break the membrane down and "liberate" the previously restricted phenol. The invader thus triggers the release of a counterweapon hidden in a storage vault in the cell.

In recent years, a more active defense against microbial invaders has been shown to exist in some plants. When they are invaded by filamentous fungi, these plants respond by making a germicidal compound that they did not contain before the invasion. These substances are called phytoalexins, from the Greek *phyton*, "plant," and *alexin*, a warding-off substance. Unlike antibodies, they tend not to be specific with regard to fungal toxicity, and are restricted to a zone immediately surrounding the infected area. Thus, they are of no use in providing systemic immunity.

One phytoalexin, a complex phenol called pisatin, has been isolated from pea pods inoculated with the pathogenic fungus *Ascochyta* or the nonpathogenic fungus *Monilinia*. In general, pea varieties resistant to the pathogenic organism form more pisatin than nonresistant varieties, a picture consistent with a functional role for pisatin in disease resistance. Some especially virulent invaders have the ability to break down the pisatin that is formed by the plant, which may account for their virulence. Plant and invader appear to deliver thrust and counterthrust in the chemical battle for survival.

Tissues invaded by filamentous fungi also seem to form large quantities of certain oxidative enzymes, like peroxidase. When peroxidase acts on phenols, it converts them to "free radicals," especially active forms of these compounds that may be the actual toxic material acting against the fungi. Thus, the active defense mechanism of the plant may involve not only the formation of a potential chemical toxin but also of the catalytic "fuse" that activates it.

There is much interest in these recent findings among plant geneticists, for the production of new agriculturally important and disease-resistant crops may be linked to phytoalexin production and activation. If successful, such an approach might even lessen our dependence on troublesome, externally applied pesticides.

Columnist Arthur W. Galston teaches biology at Yale University.

George Catlin:

Pictorial Historian of Aboriginal America

Despite physical and financial hardships, he ventured into the great American West and the jungles of South America "to rescue from oblivion the looks and customs of the vanishing races of native man in America"

by Phillip Drennon Thomas

George Catlin, born at Wilkes-Barre, Pennsylvania, on July 26, 1796, grew up in an atmosphere permeated with stories of Indian life. As a young girl, his mother, Polly Sutton Catlin, had been taken prisoner briefly by Indians during the Wyoming Valley massacre of 1778. His father, Putnam Catlin, a successful lawyer, moved his family to a new home near the Susquehanna River in New York shortly after George was born. Putnam Catlin was a stern practitioner, and in guiding the endeavors of his fourteen children, he decided that George (the fifth child) was also going to be a lawyer.

As a young man, George Catlin, although small of stature, was darkly handsome with deep blue eyes. He had a talent for making lasting friends that would later be instrumental in putting him at ease with Washington politicians, the tribal chiefs of the Plains Indians, and the crowned heads of Europe.

At the age of twenty-one, he began his law studies in Litchfield, Connecticut, passed the bar examination in less than two years, and commenced the practice of law in Lucerne County, Pennsylvania. Four years later, thoroughly bored with the life of a successful eastern member of the bar, he gave up his practice and moved to Philadelphia to pursue a boyhood passion: the study of art.

The year was 1823. George Catlin, at twenty-seven, was embarking on a new career with the same self-assurance that would soon send him on a forty-year adventure. He began the arduous task of becoming a painter by studying the paintings in the Peale Museum in Philadelphia and by taking instruction from the famous portraitist Thomas Sully.

He found his first success with miniatures, and from them, he progressed to larger portraits. From 1824 to 1830, Catlin prospered as a portrait painter in New York City. His ready wit and pleasant personality, as well as a modicum of skill, made him a popular society portraitist. It seemed in 1826 that Catlin would have a successful career capturing on canvas the flattering features of the wealthy.

Yet this life of relative comfort did not satisfy him. Even his election in 1826 to the Academy of Fine Arts—the later National Academy—did not convince him that he had found his destiny. As he said, his "mind was continually reaching for some branch or enterprise of the arts, on which to devote a whole life-time of enthusiasm." After a chance viewing of a delegation of western Indians who had stopped in Philadelphia on their way to Washington—"arrayed and equipped in all their classic beauty, with shield and helmet, with tunic and manteau, tinted and tasselled off, exactly for the painter's palette"—George Catlin knew he had found the subject for his "life-time enthusiasm."

He began by painting portraits of eastern reservation Indians. His first known Indian portrait is that of the Seneca orator Red Jacket, done in 1826. This work was followed by paintings of Iroquois, Mohawk, and Ottawa Indians.

Early in 1830 Catlin decided to leave his wife, Clara, behind and move to St. Louis, where he planned his embarkation to the great American West "to rescue from oblivion the looks and customs of the vanishing races of native man in America." His initial trip into the upper Missouri region in 1832 was only the beginning of his travels among the Indians of the West. As the first talented artist to journey in these areas, Catlin had the opportunity to visually document life in regions that were still relatively unexplored. He spent the years from 1832 to 1837 sketching and studying Indian life—from that of the Mandans in the north to the Comanches in the south. Catlin

commented upon these wanderings:

> I have visited forty-eight different tribes, the greater part of which I found speaking different languages, and containing in all 400,000 souls. I have brought home safe, and in good order, 310 portraits in oil, all painted in their native dress, and in their own wigwams; and also 200 other paintings in oil, containing views of their villages—their wigwams—their games and religious ceremonies—their dances—their ball plays—their buffalo hunting, and other amusements (containing in all over 3,000 full-length figures); and the landscapes of the country they live in, as well as a very extensive and curious collection of their costumes, and all other manufactures, from the size of a wigwam down to the size of a quill or rattle.

The problems involved in transporting this mass of material from the frontier were immense. But despite the theft of some of his materials, once he reached "civilization," the bulk of these objects became part of his later Indian Gallery. Catlin was an inveterate showman, and he devoted almost as much energy to popularizing and displaying his works as he did to preparing them. His first published book, *Letters and Notes on the Manners, Customs, and Condition of the North American Indians* (London, 1841), included not only his comments upon Indian life, but also 312 steel engravings of Indian themes. He also published a handsome set of 25 colored lithographs, which appeared as *Catlin's North American Indian Portfolio: Hunting Scenes and Amusements of the Rocky Mountains and Prairies of America* (London, 1844). The large circulation of these works gave many people a chance to see Catlin's artistic interpretation of lands and peoples they would never see at firsthand.

In 1837 Catlin's flair for the dramatic became institutionalized when he exhibited his Indian Gallery for the first time. With modifications, his Indian Gallery became a prototype for subsequent "Wild West shows." In the New York *Commercial Advertiser* of September 23, 1837, Catlin ran the following advertisement describing his new venture:

> Catlin's Indian Gallery. Opens for exhibition on Monday Evening, the 25th instant and will be continued each evening . . . There will be several hundred Portraits exhibited, as well as Splendid Costumes—Paintings of their villages—Dances—Buffalo Hunts—Religious Ceremonies, etc. Collected by himself, among the wildest tribes of America during an absence from this city of seven years. Mr. Catlin will be present at all of these exhibitions giving illustrations and explanations in the form of a lecture.

Using paintings to illustrate his lectures, Catlin vividly described his life beyond the frontier, and established an interest in the American West as a subject for visual documentation and artistic interpretation. Despite numerous problems, the gallery was exhibited in New York, Washington, Philadelphia, and Boston.

One of Catlin's great desires was to sell his Indian Gallery to the United States government, and from 1838 until his death in December, 1872, he sought to achieve this goal. Support was found in Washington: Henry Clay, Daniel Webster, and William H. Seward endorsed Catlin's plans for a national museum to house his Indian collection. Nevertheless, year after year the winds of political fortune prevented congressional appropriations for this project, and Catlin died without knowing of the final disposition of his life's work.

While many applauded Catlin's work and the merits of his paintings, other voiced sentiments that were anathema to Catlin. In 1847 a congressman from Florida stated, "I am opposed to purchasing the portraits of savages. What great moral lesson are they intended to inculcate? I would rather see the portraits of the numerous citizens who have been murdered by these Indians. I would not vote a cent for a portrait of an Indian."

In the 1852–53 congressional session, the bill endorsing the purchase of Catlin's collection failed by one vote, that cast by Jefferson Davis. Although Davis had been a companion of Catlin's during the Southwest expedition in 1834 and had earlier praised Catlin's works, he voted negatively because of his party's principles.

Having failed in his first attempt to persuade the United States Congress to purchase the collection in 1839, and after having exhausted the possibilities of financial gain with the gallery in America, Catlin sailed for England with eight tons of Indian artifacts and paintings, and two live grizzly bears. In 1840 the Indian Gallery opened in London's Egyptian Hall in Piccadilly. English audiences, enthralled by Catlin's displays, flocked by the thousands to see his canvas warriors. Nevertheless, after five years England's enthusiasm for these novelties of the American West began to wane, even though the exhibition now included an Iowa chief, his wife and daughter, and eleven other Iowa Indians who had joined Catlin in London.

In 1845 Catlin crossed the English Channel and prepared to display his collections in Paris. He put together a special showing for King Louis Philippe at the Louvre. Amid the masterpieces of European art, Catlin carefully arranged for the monarch's viewing of his portraits of the kings of the American plains.

When Catlin left America in 1839, he probably did not realize

Continued on page 42

A Catlin Portfolio from South America

As a painter, George Catlin's style and technique remained constant even though he worked in two separate major periods and used two different methods. In the 1830s almost all of Catlin's paintings were of North American Plains Indians, and during this time, he used not only canvas, which was easily rolled up and stored while traveling, but also a prepared paper of a light, grayish brown, which acted as an undercolor and was occasionally left unpainted.

On his trips to South America in the 1850s, however, Catlin found that he couldn't use canvas or paper—the humidity of the jungle caused them to rot and mildew during storage. Instead, he used a hard-surfaced Bristol board, which rendered a different effect from that he had achieved in the 1830s. But almost all of Catlin's paintings, whether on canvas, board, or paper, are of the same size, 19 by 25 inches, and almost all of them are horizontal.

His portraiture is a good example of the style in vogue in America at the turn of the nineteenth century. However, in rendering the human form his technique and composition are unacademic. It is because of this lack of training with regard to the conventional studies of human anatomy that he achieved such a high degree of natural proportion in his Indian subjects. Similarly, although there is no record of Catlin ever having painted an architectural scene requiring a linear perspective, his landscapes display a true perspective.

Catlin had a strong artistic memory, an ability that allowed him to portray much action in his work. Many of his paintings had to be done from memory because his figures are generally represented in vigorous motion: they chase animals, they run, they jump, but they have none of the studied motion of the academic painters. Except for his portraits, there is little rigidity in his work, and his depiction of motion is usually accurate.

Catlin's scenes are best observed close up: landscapes and animals are minutely and delicately detailed, and the dress of most of his Indian subjects is accurately depicted, thereby providing a good ethnographical record. Some of the South American paintings, however, especially those completed in Brussels from memory, display inaccuracies in dress and artifacts.

All of the paintings reveal a thin evenness of paint, and there are no traces of retouching. His palette was limited, but contained all the essential colors. Generally, the paintings are light but not bright in tone, with bright colors used sparingly in small touches and accents. Yellow ocher is much used, as are the dark browns, umber, and probably Vandyke brown. White lead, a bright yellow, a light red, and two bright reds (probably vermilion and rose madder) balance out the palette. Unlike most painters of the time, Catlin used cobalt blue, and what appears to be an indigo blue, only in the painting of nocturnal scenes. Except for some of his jungle greens, his colors remain pure, lending an inordinate amount of value to numerous details.

Catlin's paintings are important, not for his technique, but for his attitude toward his subject matter. In all of the paintings, the subjects are handled realistically. Each portrait reveals an individual—a personality—in all of his or her trappings. There is nothing idealized or romanticized about the subject. His paintings show us Indians in the chase, in the dance, in all of the important incidents in their lives.

On the following eight pages are paintings representative of Catlin's work during his travels in South America in the 1850s. Descriptive notes are on page 41.

The Handsome Dance—Goo-a-give (1852).

Entrance to a Lagoon, Shore of the Amazon (1852).

Lengua Medicine Man with Two Warriors (1856).

Driving the Pampas for Wild Cattle—Conibo (1852).

A Small Lengua Village, Uruguay (1856).

Tapuya Encampment (undated).

33 *The Handsome Dance—Goo-a-give (1852).* To honor Catlin for his "great medicine," the chief selected three young maidens to perform the dance. Also known as the "Glad Dance," it was accompanied by a drum and a traditional chant. The girls' bodies were painted white with pipe clay; their cheeks were reddened. Long silver pins strung with blue and white beads were run through their lower lips. The dancers held both feet together and, never lifting their toes off their individual jaguar skins, moved up and down, undulating slowly in perfect rhythm. This Venezuelan coastal tribe living near Caracas was decimated by smallpox at the close of the eighteenth century.

34 *Entrance to a Lagoon, Shore of the Amazon* (1852). "The dense and lofty forest, into which the sun's rays can never penetrate, are before us. Twining and twisting vines, like huge serpents, are rising to their tops; some clinging to their trunks, others hanging suspended in the air like broken cordage, and on them, in clumps and bouquets, the most beautiful parasitic flowers. Crowded out from these thickets of trunks and branches, leaves and vines, so thickly grouped that neither sun nor wind can penetrate, we see the strangled palms and other trees pushing their heads out, and bending over the river for a breathing place."

George Catlin

35 *Lengua Medicine Man with Two Warriors* (1856). The Lengua lived along the Uruguay and Paraná rivers, near San Pedro, sixty miles upstream from Buenos Aires. Once numerous and warlike, their numbers were greatly reduced by smallpox in the early 1800s. Their villages consisted of single-family dwellings, usually connected by a common shed roof. The warrior at left has stuffed bird skins on bead earrings; the one in the center has a silver ring through his nose, silver earrings, and a feather pendant hangs from his lower lip. The medicine man, at right, wears a wooden disk in his lower lip, stone disks in his earlobes, and is outfitted entirely in snakeskins. The peace pipe, quiver, and bow and arrow of the warrior, center, are not accurate for the Lengua; the design and ornamentation are reminiscent of the Shoshoni Indians of the North American plains.

36 *Driving the Pampas for Wild Cattle—Conibo* (1852). On the Pampa del Sacramento near the eastern sierra of the Andes, great herds of wild cattle and horses roamed free, and the Connibo Indians hunted them for meat, hides, and horsehair (used for ornamentation). The bola was the main hunting weapon and both men and women used it. The bola is made up of three thongs, six to eight feet long, weighted with half-pound lead balls. Game was stalked to within attacking distance; then, at full gallop, the hunter swung the bola over his head and let it go with a slight slinging motion. The loose ends of the bola wrapped themselves around the neck and legs of the animal, bringing it down so that the rider could kill it with a lance.

37 *A Small Lengua Village, Uruguay* (1856). This village near the mouth of the Rio Negro is one of many that sprang up when the tribe scattered after a smallpox epidemic in the 1830s. The Lenguas, wary of the white man and frightened of his ways, were extremely difficult to capture in oils, for they believed a reproduction of their likeness would rob them of their identities. Catlin overcame this difficulty with a simple ruse. Upon approaching a village, he would have his companion fire his rifle over and over to amuse and awe these river people while he sketched them, hidden from their view behind the blinds of the small river steamer's light cabin. Later they would stop at a secluded place on the river and Catlin would put his sketches to oil.

38 *Tapuya Encampment* (undated). Catlin was either confused by his notes or this particular tribe refused to identify itself to him because *tapuya* is a general word that refers to any enemy of the Tupi group of Indians. It has been suggested that these could possibly be Carib Indians, but that would have placed the encampment 1,000 miles away at the mouth of the Orinoco. The structure at the right is North American, as are the shape and structure of the bows and arrows of the dancers. The style of body painting, the anklets, and the feather headdresses are reminiscent of the Sepibo Indians, a small tribe that lived on the banks of the Ucayali River (more than 1,700 miles inland from Catlin's reference to "the north shore of the Amazon, above Óbidos"). The Sepibo were completely wiped out by smallpox in 1853.

39 *Return from a Turtle Hunt—Conibo* (1852). This pampa Indian tribe was located near Nauta on the Ucayali River. An aggressive people, they lived on the border of the Pampa del Sacramento and built their villages on the edge of the forest, away from the river. The villages usually consisted of one shed, 150 to 200 yards long, that could house several hundred persons. Individual families were separated by light screens, and everyone slept in hammocks slung between posts. Because the roofs of their "villages" were thatched with palm leaves and they fired their pottery, they were considered to be one of the advanced tribes in the area during the 1850s. Although at home on the river and excellent canoe builders, they were primarily plains hunters, and Catlin compared their horsemanship to that of the North American Sioux Indians. Turtle shell was prized for ornamentation and the meat was reduced into "turtle butter," a delicacy.

40 *Orejón Indians* (1852). A small fishing tribe that was once located near Nauta at the mouth of the Ucayali River. Their dwellings were single-family, open-sided sheds of light poles and palm fronds. Because his young wife was afraid that the finished painting would steal her identity, the chief held her while Catlin painted her portrait. Catlin assuaged her anxiety and that of the others by "painting out" their faces with a mixture of clay and water. Since clay will not adhere to oil paint, Catlin was able to remove it easily after he left the village. The bows held by the various members of the group are inaccurate for South American Indians; the "cupid bow" shape is indigenous to North America.

Paintings by George Catlin, Paul Mellon Collection, National Gallery of Art, Washington, D.C.

Continued from page 31
that he was going to spend almost all of the next thirty-one years of his life abroad. These were years of economic hardship and personal sadness. His wife and son died of pneumonia in Paris and his three daughters had to be sent home to America. For years he was barely able to meet the increasing demands of his creditors, and despite the publicity that attended his showings, he was never able to gain financial security. To satisfy his creditors, his collections were sold.

Deaf, lonely, and financially destitute, the 54-year-old Catlin sought new adventures. Looking for any opportunity to improve his fortune, he became interested in a tale of lost gold mines in the Crystal (Tumuc-Humac) Mountains of Brazil, which was told him by a companion he had met while working in the Bibliothèque Impériale at Paris. Catlin wrote: "According to this tradition, the Spanish miners, after having accumulated great riches, were attacked by Indians and massacred in their houses, or driven out of the country, leaving their gold behind them. This wonderful relation, with other corroborating legends I had received, had enough probability to excite my cupidity."

With the most sanguine expectations of wealth before him, Catlin sailed for Havana in 1852. From there he proceeded to Caracas, then to the Orinoco River, the Demerara, and finally up the Essequibo River to the Crystal Mountains of Brazil. With a new Colt repeating rifle—and confidence in his ability to again negotiate an uncharted wilderness—Catlin set out, accompanied by Caesar Bolla, an escaped six-foot, two-inch slave from Havana.

Unfortunately, Catlin and his companion demonstrated a remarkable ineptitude in their search for gold. After finding a few small nuggets, Catlin abandoned his quest.

His travels in South America were for the most part conducted on the great river systems of that continent. He became deeply interested in the variety of flora, fauna, and peoples, and by 1857 he had made three trips to this still relatively unexplored region.

As always, he sought out the Indian tribes. Here he sketched and observed the Caribs and Macouchis, the Akawais and Warrows in Dutch Guiana and the Arawaks of the Rio Corontyn. Catlin judged the Indians he met by the standards of North American Indians, frequently comparing the two.

> These people are generally rather small in stature, and inferior to the North American races, but not inferior to some that may be found there; and enough like them in features and color, as well as in customs, to stamp them, without a doubt, as a part of the great and national American family.
>
> These tribes in this vicinity, which show a strong resemblance to one another in complexion and customs, also speak a language much resembling, showing them to be a family group. Their skin is a shade darker than that of the North American races, and their modes of dress very different; the latter of which is undoubtedly the result of the difference of climate. The weather in the tropics admits of but little clothing, and these tribes are chiefly naked, both women and men, seldom wearing anything more than sandals under their feet, and mere "figleaves," or bandages, about their loins; yet they have and support a strict sense of decency and modesty at the same time, for which these poor creatures deserve a great credit.

In Brazil, Catlin encountered Indians that were different from those that he had met farther north. With Spanish and Portuguese legends of the Amazons filling his thoughts, Catlin sought to observe the Indians of the Amazon River system. He was cautioned to be aware of the cannibalism practiced by these Indians. Undaunted by such warnings, he proceeded on his journey, where he encountered neither Amazons nor cannibals.

> The nearest thing I could discover or hear of to the Amazons were the women, in some of the tribes, who were famous for mounting their horses, and, with the deadly bolas, to bring down the wild ox or the wild horse as easily as their husbands could. And on inquiring amongst the various villages for the cannibals, I was laughed at even by the women and children for asking so ridiculous a question; a thing, apparently that they never had heard of before.

Reaching the mouth of the Amazon, Catlin realized that overland travel into the interior of the basin was impossible. Hence, he secured passage on a trading boat owned by a Portuguese river merchant; and on board this craft, he traveled 1,000 miles up the river to Óbidos. For sixty-nine days, the obliging merchant stopped at any site that Catlin designated.

Initially, Catlin had intended to invite Indians on board and paint them, but his inaugural attempt to do this was a failure. The Indians were fearful that they would be harmed if their portraits were painted with their names on them.

> From the events of these two days, I foresaw the difficulties ahead of me, and was nearly discouraged. The shores of this mighty river, lined with tens of thousands of human beings unchanged by civilization, and in their simple, native habits and in their own homes, the most interesting display of savage life that could appear to me during my existence, and for which I was a voluntary and unknown exile to this distant land, and my project to be lost, or to be achieved by a maneuver.

The maneuver Catlin referred to involved some rather successful subterfuge on the part of the river travelers.

Our boat was afterwards anchored in front of their villages and encampments, some four or five yards from the shore, bringing the excited groups with their toes to the water's edge, when I took my pick of them, at full length, as my portfolio was screened from their view by the bulwark of the boat or by the transparent sides of the cupola; whilst Smyth [a companion], conspicuous in his scarlet capot, riveted their attention by discharging cylinder after cylinder of my revolver rifle, the first ever seen on that river; and if the seance was not long enough for my object, the boatman held them amused with his fiddle, which often set them to dancing and at other amusements, or displayed on the bulwark of his boat a variety of bright-colored cotton shawls and other attractive objects, with which, as a trader, he was supplied, and struck up a trade for fish, fruit, and turtle's eggs, with which we were in this way abundantly supplied.

At the conclusion of his Amazon adventures, Catlin traveled down the Ucayali River and crossed the Pampa del Sacramento to reach the eastern foothills of the Andes. He was particularly impressed by the Connibos who lived on the fringes of the pampa. Their weapons were especially interesting to him, and he persuaded a member of the tribe to demonstrate the efficacy of their blow guns and poison darts. He painted numerous portraits of the people he met during this trip, but again he encountered objections from a medicine man who thought that the pictures would bring harm to his people. With continued ingenuity, Catlin solved this problem by unpainting their portraits. "This seemed to afford them a great relief, and in a few minutes they were all unpainted, covered in with a thick coat of clay, which would perfectly preserve them until I wanted to see them again. All were satisfied."

He concluded his initial trip to South America by crossing the Andes to Lima and then taking a steamer up the Pacific coast to San Francisco.

Catlin's second journey to South America began in the fall of 1855. From Buenos Aires, he followed his traditional practice of visiting tribes along the major rivers. He traveled by steamer up the Paraguay to Paraná, and by trading boat he proceeded upriver to Concepción. Reaching the Uruguay River, he then floated seven hundred miles down the river in his own pirogue.

To continue his exploration of the lower half of the continent, Catlin made his third and final trip to South America in 1857. From Buenos Aires, he bought passage on the sailing packet *Gladiator*, and cruised the littoral of southeastern South America. The people of the southern tip of the continent were the last Indians of South America to receive his careful scrutiny. He found that the tribes of Tierra del Fuego were particularly adept at making flint weapons. Safely passing through the Strait of Magellan, he proceeded north to examine geologic formations in Venezuela and shortly thereafter returned to a small studio in Brussels, where he began to work up the sketches he had made on his journeys.

Catlin's interests often led him into strange byways. In 1860 he published a brief pamphlet, *The Steam Raft, Suggested as a Means of Security to Human Life upon the Ocean.* A more intriguing work, *The Breath of Life; or Mal-respiration and Its Effects upon the Enjoyments and Life of Men,* was published in a number of editions. Its main theme was that people would be healthier if, following the example of the Indians, they slept on their backs and breathed through their noses. This treatise, which also appeared under the title *Shut Your Mouth and Save Your Life,* may have influenced the creative and eccentric Cambridge mathematician C.L. Dodgson, who had eagerly purchased one of the earlier editions. Dodgson, when writing as Lewis Carroll, may have used it as a model for the illustrations and lettering in *Alice's Adventures in Wonderland.*

When Catlin returned to the United States in 1870, the first secretary and director of the Smithsonian, Joseph Henry, invited him to exhibit his new works at that institution. As a courtesy, Henry allowed Catlin to use some rooms in the front tower of the Smithsonian as a live-in studio. Again, Catlin dreamed of selling a collection of his works to the United States government, and again his dreams were shattered by interminable delays. He died two days before Christmas in 1872, without knowing that his earlier Indian Gallery would become one of the prized possessions of the Smithsonian.

Catlin had dedicated his life to recording the Indian cultures of the New World. As he had once remarked:

> I have, for many years past, contemplated the noble races of red men, who are now spread over these trackless forests and boundless prairies, melting away at the approach of civilization. Their rights invaded, their morals corrupted, their lands wrested from them, their customs changed, and therefore lost to the world; and they are at last sunk into the earth, and the ploughshare turning the sod over their graves, and I have flown to their rescue—not of their lives or of their race (for they are *"doomed"* and must perish), but to the rescue of their looks and their modes, at which the acquisitive world may hurl their poison and every besom of destruction, and trample them down and crush them to death; yet, phoenixlike, they may rise from the "stain on a painter's palette" and live again upon canvas and stand forth for centuries yet to come, the living monuments of a noble race. ■

A Most Sociable Bird

by Barbara R. MacRoberts and Michael H. MacRoberts

From feeding young to building and defending granaries, the life of the acorn woodpecker is a group effort

As its name so aptly signifies, the acorn woodpecker has cast its lot with the oaks; the birds depend on these trees for acorns, which they store each autumn, and for sap on which they feed from midwinter through summer. They are, as well, master flycatchers, and grasslands provide the other essential of their diet—winged insects. Still more remarkable in a bird belonging to a family characterized by secretive and solitary habits, the acorn woodpecker is gregarious. Individuals live in year-round groups, and the members of each group jointly defend a territory from neighboring acorn woodpeckers.

The acorn woodpecker is a common resident of the mixed oak woodlands that extend from southern Oregon through California and the southwestern United States into Mexico and Central America. The woodpeckers are particularly abundant in California; in the center of the state, in the oak woodlands that scatter across open grassland, they are a presence of every day. But where dense oak forest towers for miles into the hills or where the chamiso and manzanita take over and the oaks grow small and sparse, acorn woodpeckers are virtually absent, until high on a ridge along oak-fringed flatlands they are met with once again. It is the combination of mature oaks and surrounding grassland that pinpoints the habitat of this most curious woodpecker, and its wide range coincides exactly with this type of habitat.

They live in groups composed of both sexes and typically numbering four to eight individuals, although some groups have as many as twelve members and others as few as two. All birds are attached to a group, and there is usually no population of "floating" individuals. In most groups the sex ratio is about equal; but in some, males outnumber females, while in others the reverse is the case. For some time, it was assumed that males outnumbered females; this apparent discrepancy arose because all young, before the autumn molt, possess the adult male head coloration: white forehead and red cap. Not until molt can young females be distinguished from their male siblings by the broad black band separating the red cap from the white.

Breeding occurs within the group, and although the details of reproduction are not yet fully understood, what is presently known suggests that only one pair in a group mate to produce the single clutch. Conspicuous courtship does not occur, but during the first few days after eggs are laid in each group, two birds (a male and a female) are conspicuous in their attentions to the eggs, and these individuals are probably responsible for the clutch. Within a week after laying, however, all birds in the group take turns incubating the eggs, more or less equally. In large groups this may involve as many as ten birds; in others, as few as a male, a female, and one yearling share the task.

When the young have hatched, they are fed by the entire membership, and the unequal work load that initiated incubation no longer exists. After the young have fledged, they continue to beg from the adults, who feed them with waning frequency well into the autumn. If there is a second brood in midsummer, the adult birds again take on the full burden of incubation and feeding with apparently no help from young fledged earlier in the season.

It appears that individuals usually remain in their natal group for at least the first year, and probably some will spend their entire lives there. Other individuals change groups, however, and when this occurs it is not always a solitary bird that does so—several may move together. Many territories have been occupied for decades and the founding birds are certainly dead; it is therefore likely that present residents are their descendants—their children, grandchildren, and great-grandchildren—with, through the generations, an occasional outsider establishing itself.

It is in the later summer that the acorn woodpecker most readily catches the attention. As the last of summer's long dusty days

An acorn woodpecker rearranges food stored for the winter. Acorns shrink as they dry out, and the birds then transfer them to smaller holes in their granaries.

Because the acorns have been wedged in tightly, the nutmeat can only be removed by pecking out the base of the shell and chiseling away pieces from the hull.

Top right: a partial albino shares a branch with a woodpecker of normal plumage. An area of oaks and open grassland, at right, is the habitat of the acorn woodpecker.

give way to autumn and the oaks are heavy with the year's nut crop, the woodpeckers begin to feed on green acorns.

Like large, clumsy chickadees, they clamber about among the terminal twigs and leaves. With its bill, a bird grasps an acorn by the pointed end and tugs and twists until it pulls free from its cup. If it does not come loose, the woodpecker pecks away the surrounding leaves and jabs at the stem until it weakens. Again the bird grasps the nut in its bill and twists it until it breaks away, usually with adhering stem, cup, twig, and a few remaining leaves. Dropping from its awkward perch, the woodpecker flies with the acorn and trailing debris to an anvil. Anvils are special locations on the upper surfaces of horizontal limbs where natural cracks provide an area suitable for wedging in the acorn. Wedging the nut firmly in lengthwise, the bird aligns itself end on, and directs a few sharp blows along the midline of the shell until it punctures. Then, driving its bill through the nut, with a twist of its head, the bird splits the nut into two neat halves. The entire maneuver is quickly done, deft and precise, and all the more striking in its precision for having been done solely with the bill; at no time does the woodpecker use its feet to steady or orient the acorn. The bird now breaks the nutmeat into swallowable bits and flings away the pieces of shell or drops them directly beneath the limb where a midden quickly accumulates. The scatter of debris beneath a group's anvil sites pinpoints their locations and provides an excellent manual on acorn-handling techniques.

For about a month, the woodpeckers feed on green nuts, but as the acorns ripen and their shells become firm and tough and loosen in their cups ready to fall, the birds in each group begin to harvest and lay in their winter stores. Although some of the harvested nuts will be eaten immediately, the majority are stored.

An individual does not make its own cache of nuts, but each contributes, with no individual

Granary sites are normally oaks or conifers, but sometimes power poles or even the shingles of old buildings are used.

proprietorship, to the common stores. Every member of the group takes part during the four to six weeks of the harvest when the acorns of the several oak species within the territory are gathered and deposited in one or two large storage trees. Granary sites, either oaks or conifers or sometimes telephone poles, are easily identified by the hundreds of holes that have been drilled in trunks and limbs and by the thousands of green and amber nuts that run in rows within weather cracks and poke out from holes excavated in the conveniently soft bark of old stumps. Favored sites for hole making are dead and decaying limbs and the deeply crenelated bark of mature valley oaks. Where pines and oaks are mixed, the woodpeckers appear to prefer the softer-barked conifers as granaries. Close examination of a storage tree shows that the holes have been more or less evenly spaced over the surface, giving the impression of a well-conceived pattern. Holes measure about half an inch in diameter and are approximately one and a half inches deep. But comparisons between the storage trees of several woodpecker groups, each storing acorns of different species, show that the birds prepare holes that fit the acorn species being stored. The nuts are wedged tightly into these prepared receptacles and have generally been sunk well below the surface.

The woodpeckers prune the acorns directly from the oaks and only rarely bother with nuts that have fallen to the ground. The acorns that are stored are mature and ready to fall, and the birds have little difficulty freeing them from their cups—a few sharp twists and tugs generally suffice. Each harvested nut is transported, blunt end outward, to an anvil. Here the bird lays the nut down as if to open it, but instead only maneuvers it around to reverse the direction of carriage.

The woodpecker then flies with it, now with the pointed end outward, to the storage tree where it hitches about in search of a proper-sized hole. It passes up some, inspects others by inserting the nut, and finally, having rejected holes that are too large or too small, arrives at one of the correct size and pokes the acorn in, base outwards. It then wedges the nut farther into the hole by vigorous pounding. The bird may now attempt to remove the acorn by tugging at it or by pecking around the margin of insertion; if the nut holds fast, the bird hitches away and perhaps tests the security of other stores in the immediate vicinity before flying off to harvest another.

Although most acorns are stored in prepared holes, other storage areas are also used. As harvesting progresses, some birds begin stowing nuts in abandoned roost holes. The deeply ridged bark of old valley oaks is used to advantage, and nuts may even be tucked beneath the loosened shingles and into cracks in the dilapidated walls of old buildings. Desiccation cracks in power poles are a favorite site.

Typically, the woodpeckers store whole acorns, but as autumn advances and the prepared holes are filled, the birds split the nuts and store halves and fragments in weather cracks or similar crevices unsuitable for whole nuts. These may be stored shucked or with shell adhering.

Harvesting does not end with putting an acorn into a storage hole, however. Once the nut has been stored it will probably be removed and re-stored several times in the course of the season. Acorns, as they dry, shrink considerably, and as desiccation progresses, they loosen in their first receptacles. Without further maintenance, many of the stores would soon fall from their holes. During the hundreds of trips each bird makes daily to lay in stores, it will pause to hitch over the other stores and peck at nuts already in place. It pulls those that are loose from their sockets and carries them off to store elsewhere. Re-storing is a major activity through the latter part of the harvest season and for at least six weeks after the harvest is done.

Because the nuts have been wedged in so tightly, the majority cannot be removed intact, and the birds can only extract the nutmeat by pecking out the base of the shell and chiseling away pieces from the hull as it remains in place. Once the meat has been removed, they tidy up the storage hole by pecking out the broken hull and throwing the bits away until the hole is free of debris and ready for next year's nut crop.

As winter runs its course and the stores are eaten, the birds continually clean and repair emptied holes, and granary space is constantly added to by the construction of new holes. The birds do not make a single hole, then store in it before making another; hole making is an ongoing activity in which, like harvesting, all members of the group participate.

Storage-hole construction is time consuming, and the thousands of holes in a granary are the work of many generations of woodpeckers. New holes are begun at points congruent with the pattern of existing holes; a bird begins drilling by first making a V-shaped wedge and slowly enlarges this by excavating out the sides until a thin-necked socket is achieved. It is rare that one bird is responsible for the completion of a new hole; at any one time many holes will be under way, the authorship of each belonging to several individuals.

Acorns, however, are not the only winter food; in midwinter, sap is added. The birds now enter into another group activity: several individuals begin drilling through the bark on the upper

surface limbs in the middle and upper canopy of valley oaks. The woodpeckers do not ring the tree with tiny punctures in the manner of sapsuckers but rather, space the holes as if they were preparing a storage surface, except that the diameter and depth of sap holes are not so great.

The number of holes over a given sapping area may be as numerous as those covering a storage limb of similar dimensions. The monotonous tap-tap-tap of sap-hole construction may go on for several hours at a time; each bird spends several minutes drilling; then switches to feeding for another few minutes, scooting rapidly from hole to hole up and down several limbs or flying to another tree and hurriedly probing a series of fresh holes with its long, bristle-brush tongue.

The woodpeckers continue to sapsuck through the remaining winter months, but as spring arrives, individuals now center their sapping activities in the live and black oaks and ignore altogether the valley and blue oaks they used earlier. In June and July sapsucking is a particularly frequent feeding activity, but as autumn arrives the woodpeckers abandon their sap trees and turn once again to acorns.

On the not infrequent warm days in midwinter, the birds take advantage of yet another source of food: insects. Unlike most woodpeckers, however, acorn woodpeckers do not spend much time gleaning from the bark of trees except when a particular emergence occurs, as in the case of tent caterpillars, and the birds never drill for wood-boring insects but take their prey on the wing as do phoebes and flycatchers.

As winter retreats and the native shrubs one by one contribute their different perfumes to days now consistently warm, the birds depend less and less on their acorn stores, and by late spring feed almost exclusively on insects and sap. What stores remain in the granaries are left virtually untouched.

When insects emerge in considerable numbers, groups typically spend much of the day flycatching. One bird begins hawking from a favorite stump and before many minutes, all of them are swooping among the insect swarms that sift like dust motes up from the open grass and brushy understory that form part of each group's territory.

The woodpeckers flycatch from the uppermost branches of any trees tall enough to offer good visibility and from stumps and branches just above the grass. On good hawking days the horizon above the oaks and sycamores is animated by black-and-white forms boomeranging upward with strong, steady wingbeats. Near-vertical flights take some birds soaring in steep ascents punctuated by abruptly closed wings as, the insect caught, the bird tumbles earthward; at the last moment its broad wings unfold and it lands abruptly back on its perch. Other members of the group hover, like bluebirds, low above the grass and nip up low-flying prey. The seemingly endless succession of hawking flights is broken only by brief intervals during which each bird sits panting or flies off to give a mouthful of prey to the nestlings, which are fed primarily on insects.

Hawking flights are usually short sorties of between four and seven seconds in which a single insect is caught; more rarely, a bird makes longer flights in which it picks several prey from the air before landing.

On days when an insect emergence has occurred, the woodpeckers frequently store much of the day's catch in weather cracks and under loose bark. Typically, birds use special areas of the hawking trees over and over for caching rather than individuals scattering their stores helter-skelter through the trees. Such caches are not the private larders of the birds that make them, and any member of the group may, and often does, help itself to the stores, particularly if they have been left overnight.

The woodpeckers carry on most, if not all, feeding activities within the territory. Territories encompass some ten to fifteen acres and are defended by the residents from members of other groups. Defense from intrusion by conspecifics does not center on any particular locations within the area, but rather at points here and there on its periphery, from which strangers are chased, or at any points within the boundaries if an intruder advances that far.

Any territory will enclose some acreage that is largely unused by the residents but which they nonetheless defend: oak saplings too small to be used for granaries or for the harvest and patches of dense woodland of little value for flycatching. Each group tends to center its feeding in particular areas at any one time and may use these sections of the territory year after year—here using a large, decaying valley oak as a granary, there the same group of oaks as sapping sites for several seasons running—and to focus the harvest on particular mature trees season after season. However, other areas within the defended precincts may suddenly become important. Depending on the nut crop in any given year, one autumn the valley oaks may be extensively used and the following year golden oaks will provide the majority of the winter stores. One year the group may lose several roosting sites to decay or storms and, as a consequence, take over sites long unused. And woodpeckers will shift their hawking activities from place to place as insect populations fluctuate in different parts of the territory.

This total area of group use remains closed to strange birds: this parcel of habitat with its requisite sources of acorns, sap, and insects; nesting and roosting sites; and granaries with their immense investment of prepared holes and stores.

During most of the year, intrusion is infrequent and generally involves single woodpeckers that, for unknown reasons, leave their own territories for anywhere from

a few minutes to several hours and move onto a neighboring group's territory. In most cases, such intruders are quickly chased from the area by resident birds, but especially in spring some birds become persistent in their intruding and may even change groups. In these cases, the bird moves daily between its own territory and that of a neighboring group, spending long periods of time in the neighbors' territory.

When this occurs, the intruder is almost continually chased about the territory by from one to a dozen birds, some dropping out and others taking up the chase as if working on a relay system. Occasionally, the intruder is caught and both birds tumble earthward only to separate upon striking the ground. Then the chase resumes. After much chasing and fighting, the intruder is accepted into the group or is forced to return home. It is not at all clear what provokes individuals to intrude onto other groups' territories or why individuals leave their own group to join another.

In the few instances in which whole groups or portions of them move en masse into land held by other woodpeckers, however, the reasons for moving are more obvious; in all probability such movements are correlated with failure of the acorn crop within the home boundaries. When the oaks along a large section of valley bottom failed because of heavy frost the previous spring, individuals from three groups moved into the hills above the frost line displacing an entire group from its territory.

But every year does not bring such catastrophe, and groups remain in possession of their territorial holdings with little or no interference from outsiders.

In many respects, acorn woodpecker territories are unlike those of most other birds and might best be likened to human settlements or homesteads. Defended areas are not simply oaks and open grasslands but are highly and specifically modified sections of habitat. Territories not only contain the requisites for feeding and reproduction; they also have been modified by the construction of granaries, sapping areas, and nesting and roosting holes. These changes represent the accumulated work of generations of birds, and in the woodpeckers' world of real estate, such modified parcels of habitat must be in high demand. Colonizing new areas must be exceptionally difficult, even hazardous, and probably occurs only under unusual circumstances. Apparently the best way to move—if one has to—is to force a way into another group or to take over the territory of neighbors, not to begin anew in previously unused habitat.

Inside the territory that they defend against others of their own species, the woodpeckers defend several smaller territories against other species. These are particular locations within the group's territory that the residents defend from other birds and small mammals: the granaries, the oaks from which they harvest acorns, their sap trees, and their roosting and nesting holes.

Granaries are defended the year round from nuthatches, titmice, jays, and squirrels that invade them, invited by the rich supplies of stored nuts. The woodpeckers are not, however, very selective in their defense and all intruders, regardless of real nuisance value, are chased away. Even such unlikely individuals as bluebirds and kinglets are summarily chased from granary sites, and one group of woodpeckers carried proprietorship to the extreme of mobbing a deer browsing beneath their storage tree, apparently too close to the nuts wedged around its base.

A single woodpecker, diving and calling loudly, is usually sufficiently harassing to put most other birds to flight within seconds. Squirrels, however, are a more serious nuisance and may manage to clear away several nuts before the concerted efforts of the entire group dislodge them. If there are many squirrels present, the woodpeckers may eventually lose a considerable part of, perhaps all, their stores in spite of attempts to protect them.

Defense of other feeding sites changes with the seasons; the woodpeckers defend the harvest oaks only for the duration of the harvest. Once the acorn crop has been gathered, they cease defending these trees. From midwinter through the summer, each group defends its sapping sites from hummingbirds, titmice, and Nuttall's woodpeckers, which soon locate freshly drilled surfaces and often invade the trees in considerable numbers. By spring, the woodpeckers, no longer sapsucking in valley and blue oaks, turn their attention to the live and black oaks, which they defend from the same triumvirate of thieves until autumn, when they abandon sapsucking altogether and begin once more to feed on green acorns and to store.

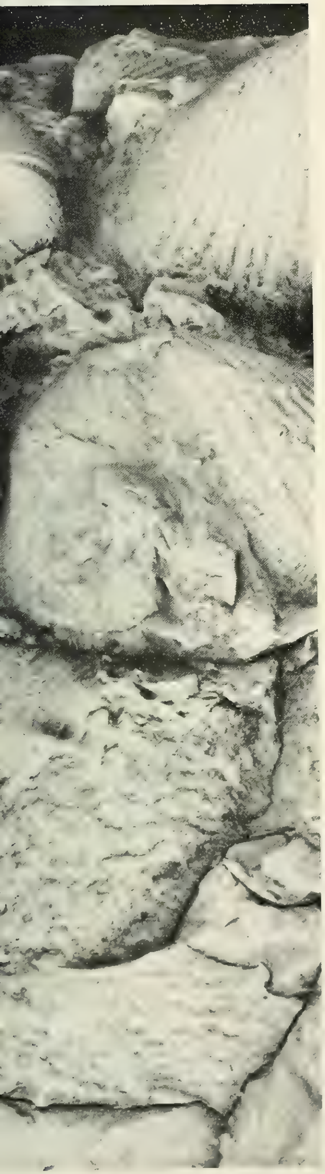
In addition to defense of food supplies within the territory, each group defends its roosting and nesting holes from intrusion by other hole-nesting birds, particularly bluebirds and starlings.

These changing patterns of defense pinpoint, in each case, important features of the territory. It would be impossible for the individuals in each group to simultaneously defend all their food sources, potential and immediate, from the many different competitors present; instead, they defend each in its season.

Many questions are yet to be answered about the acorn woodpecker, and not a few are yet to be asked, but several in particular remain outstanding: Just who are the members of groups, how stable is membership, which individuals reproduce, what are the details of dispersion, and can the cooperative aspects of acorn woodpecker life, particularly those associated with reproduction, be explained by natural selection at the individual level?

And when these questions are answered and the acorn woodpecker's story is finally told with some greater degree of completeness, it may be that it will even contribute a piece to the puzzle of why animals live in groups at all.

A Trilobite Odyssey



Moving west toward destiny has a long history in North America; 400 million years ago primitive arthropods migrated west, only to find extinction

by Niles and Michelle Eldredge

During the last 600 million years, ancient seas have flooded North America time and again. The hardened sediments of those ancient seabeds compose much of the underpinnings of our modern landscape. Along highways and railroad cuts, and in streams and quarries all over our continent, exposed rocks provide clues to the distribution and nature of these old seas. Living things, too, left stony traces entombed in the sediments they once swam over, walked on, or burrowed into.

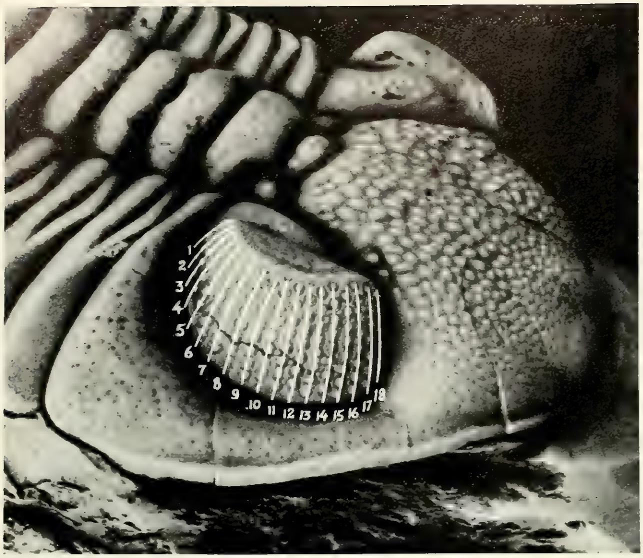
These fossils show evolutionary change in two ways. They change through time in the vertical sequence of layered sedimentary rocks. Also each species of fossil animal shows variation from place to place in the different environmental settings it encountered as it spread throughout the sea and lived on through millions of years. Evolutionary change is nothing more than variation in both time and space.

Traditionally, paleontologists have emphasized time over geographic distribution as the more important element of the evolutionary process. Strong evidence suggests, however, that evolution is not simply slow, steady change of an entire species through long periods of time. Rather, our work with several extinct invertebrates has shown that a species can exist relatively unchanged for millions of years. Real evolutionary change takes place when populations of a species become geographically isolated, allowing them to evolve in different directions from the parent species. Many of the anatomical differences between a new daughter species and its parent were established prior to isolation when the local population adapted to its specific environment.

The fossil record is full of apparently sudden evolutionary jumps, where a parent species is followed by its daughter species without intermediate fossil links connecting the two. The traditional explanation for such jumps is an incomplete fossil record, but our findings contradict tradition. When conditions permitted, animals that had evolved far away and thousands, if not millions, of years previously, migrated to territories formerly occupied by their ancestors. The sudden jump effect in any one locality actually reflects the sudden appearance of a migrant that had already evolved elsewhere. Thus, evolution requires space as well as time, and variation through space governs variation through time.

The seas of the Middle Devonian period, which waxed and waned for nearly ten million years some 400 million years ago, provide an excellent backdrop for evolutionary studies. Located near the Devonian equator, these

The trilobite *Phacops rana*, found with fossil shells in northwest Ohio, is shown here 2.75 times actual size.



Varieties of *Phacops rana* can be distinguished most easily by counting the rows of lenses on their compound eyes. The lines superimposed on the rows show that this specimen is of the most primitive, 18-row variety.

warm, shallow seas harbored a vast array of aquatic life, and outcrops preserving remnants of the varied marine environments extend from New York as far west as Iowa. The eastern shore of these inland seas stretched from New York through Virginia, along a rugged young mountain chain whose swift-flowing rivers dumped huge deposits of sand and silt into the sea. This Devonian nearshore environment must have been much like today's familiar sandy shorelines. As the sea extended westward from shore, heavier particles of sand gradually dropped out and graded into increasingly finer muds mixed with lime particles. The farther from shore, the more limy the sediments became. The thick accumulations of limestone where the sea covered what is now the continental interior were formed mostly of the millions of shells belonging to dead organisms. Thus, traveling from east to west across the Devonian sea, one can locate himself by the nature of the sediments. Sandstone predominates near the eastern shore, grading into shale, or lithified mud, farther out. Still farther west, more and more lime appears until, in what was the center of the sea, the rocks are predominantly limestone.

The trilobite *Phacops rana*, one of the 250 or more species of invertebrate animals that lived in this sea, had a particularly interesting evolutionary history. Because trilobites became extinct some 200 million years ago, we can only guess about their mode of life and study their modern relatives such as crabs and lobsters. Trilobites, however, looked more like larger versions of their distant land relatives, pill bugs. They were usually only about one to four inches long, and like pill bugs, they had a head with antennae and eyes, followed by a series of flexible segments that ended in a tail. To feed, *P. rana* probably crawled over the sea bottom searching for bits of decayed organic matter; it swept these up with its many legs and propelled the bits into its mouth. If threatened, most trilobites could roll up into a ball like a pill bug.

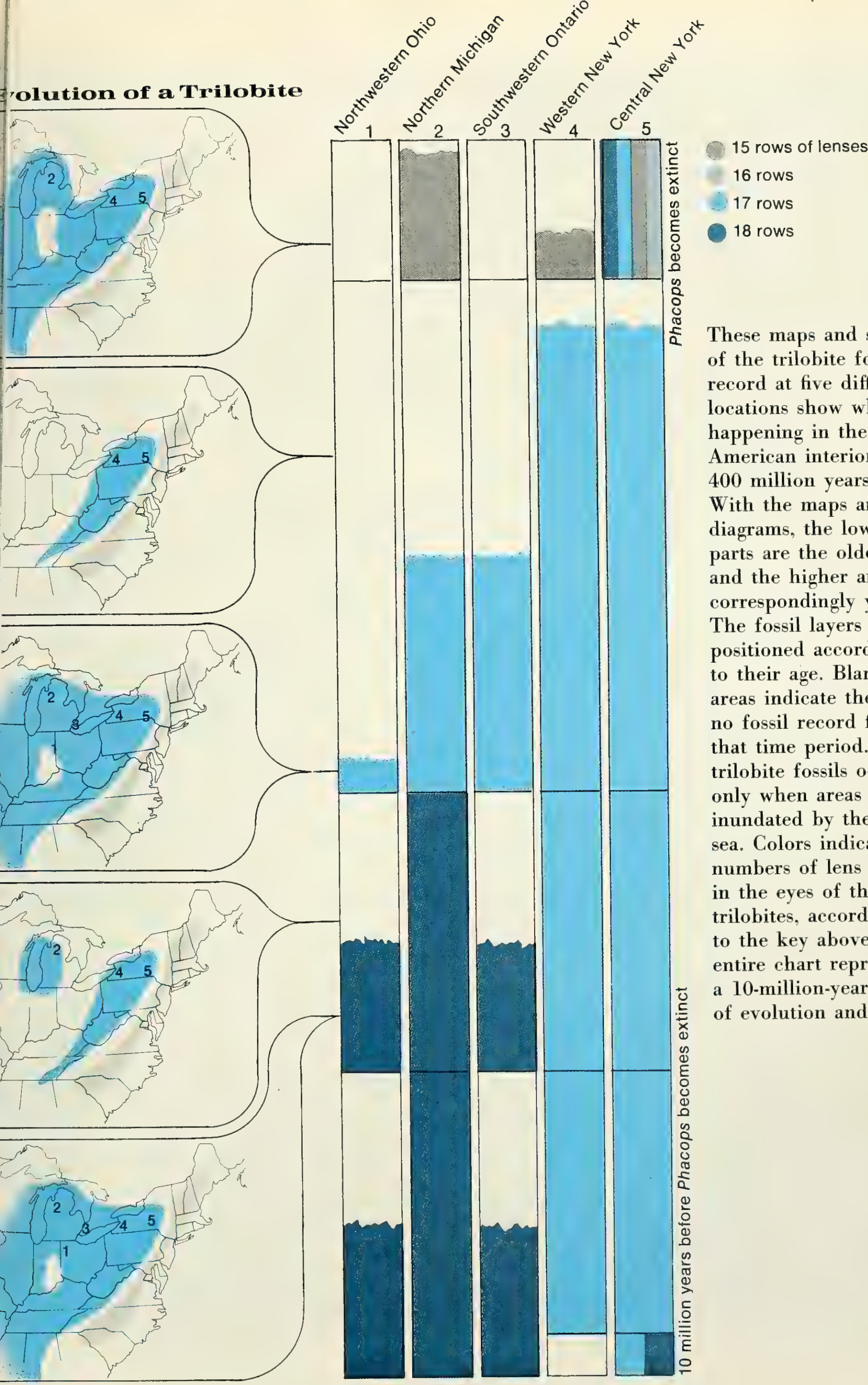
When a trilobite shed its armor, the head portion was cast aside and the animal crawled out from under the remaining shell. Then, like a recently molted softshell crab, it presumably hid from predators until its new shell hardened. Most trilobites we collect are really cast-off molts, not the remains of a dead organism.

Phacops rana had a very large compound eye on each side of the swollen, rounded middle region of the head, prompting the name *rana*, which means frog. We paid particular attention to the eyes because they show more evolutionary change than any other part of the body. Each eye is covered with many lenses arranged in vertical rows around the eye. Twice in the long evolutionary history of this trilobite, the number of vertical rows of lenses was reduced, giving rise to a new variety of *P. rana* each time.

Starting with eighteen rows in the most primitive variety, after ten million years and two jumps, *Phacops rana* ended up with only fifteen rows of lenses in the eye. Our field work clearly showed that these two important evolutionary changes took place in the nearshore environments of the eastern Devonian sea. Both times the sea had shrunk away from the continental interior, extinguishing the more primitive variety of *P. rana*. Each time the sea encroached again on what is now the midwestern United States, it brought with it a more advanced form of *P. rana*, which had been biding its time in the east.

Our trilobite odyssey began near the eastern shore of the Devonian sea. A quarry just north of Morrisville in central New York exposes the earliest occurrence of the typical Middle Devonian fauna. We found few fossils on the quarry floor, but as we

[E]volution of a Trilobite



These maps and schematics of the trilobite fossil record at five different locations show what was happening in the North American interior some 400 million years ago. With the maps and the diagrams, the lowest parts are the oldest and the higher are correspondingly younger. The fossil layers are positioned according to their age. Blank areas indicate there is no fossil record for that time period. The trilobite fossils occur only when areas are inundated by the inland sea. Colors indicate the numbers of lens rows in the eyes of the trilobites, according to the key above. The entire chart represents a 10-million-year span of evolution and migration.

climbed up through time to higher levels, more and more fossils began to appear. On the surfaces of these higher levels, brachiopods, clams, and snails were common, preserving the delicate features of their original shells.

Phacops rana is extremely rare here, its discovery being strictly a matter of serendipity, but in the few specimens we did find, we were able to see that the population was quite variable. These oldest *P. rana* occurring in the eastern sea usually developed eighteen rows of lenses in the eye, the primitive condition for this species. We found some specimens with an incomplete eighteenth row, however, while a few others showed the more advanced condition of only seventeen rows. Here, confined to a rather small area in the eastern Devonian sea, this varied population reveals *P. rana* in transition. We concluded that the advanced seventeen-row variety evolved in the area during this brief moment of geologic time, still very early in the history of the species.

Above this fauna were nearly 1,400 feet of Middle Devonian rocks, representing a span of about eight million years. Only a few miles from Morrisville, but a million years later in time, we visited a quarry on Johnny Cake Hill, once a part of the eastern sea where fossils now lie scattered richly among the trash and spent shotgun shells that litter the quarry floor. Here, all *Phacops* specimens consistently had seventeen rows of lenses. Combing the countryside along back roads, usually unpaved and unnoted on road maps, we found other quarries of even younger rocks in the area and pieced together a picture of *P. rana* essentially unchanged with seventeen rows of lenses for five to six million years.

This lack of variation in *Phacops rana* throughout such a long period of time is a remarkably graphic illustration of the tendency of organisms to persist unchanged given the persistence of their habitats. Such stasis, of course, challenges the traditional view of evolution as gradual progressive change. Only in the very youngest rocks of this area did we again encounter variation in the eyes. Near the end of its history, *P. rana* evolved an eye variety with only fifteen rows of lenses. Again we found a transitional population; this time a mixture of specimens, with seventeen, sixteen, or fifteen eye rows, briefly coexisted. Once more, evolutionary change seems to have taken place in a short period of time in the nearshore environment of the eastern sea.

We pursued our odyssey over the Devonian sea into quieter, deeper waters farther west. *Phacops* gradually became more abundant and seemed at home here in the limy offshore muds.

The area south of Buffalo, New York, is justly famous among trilobite lovers, and we found it prime collecting territory. The best exposures are natural ones in stream beds, waterfalls, and on the shores of Lake Erie.

Where Eighteen-Mile Creek meets Lake Erie, imposing cliffs rise straight up from the shore. Impressive as these cliffs are, the rocks underfoot are the real mother lode. A thin layer of ancient sediments crops out on the shore, strewn about with the modern sand and flotsam of Lake Erie. These layers are famous as Grabau's Trilobite Beds, named for the Columbia University paleontologist who studied them early in this century. And they are well named. *Phacops rana* is so common and easy to spot that hundreds of heads, tails, and even complete specimens can be gathered in half an hour. The dark hue of *Phacops* skeletons makes them conspicuous against the light background of gray shale. Here, any fossil is likely to be a trilobite since it exists almost to the exclusion of other species.

Considering the all-important eye, it was easy to determine with such an excellent sample that in Grabau's Beds, *Phacops rana* uniformly had seventeen rows. Now it remained to find out what *Phacops* was doing in the older and younger rocks of the area. As we walked along the shore, our elevation remained unchanged while the cliffs imperceptibly dipped to the south, so we found the upper beds of the cliff cropping out at shore level after a couple of miles. Thus we were able to collect *Phacops* from all the overlying rock units without resorting to Alpine gymnastics.

Below the cliffs of Lake Erie, just south of Buffalo, lies one of the world's best known trilobite beds.

In the end, every rock unit sampled at Buffalo had the same story to tell: again we found *Phacops rana* with seventeen rows of lenses persisting unchanged for millions of years, so here too, a remarkable picture of stability emerges, over space as well as time, just as in the central part of New York.

Again we headed west, farther out into the Middle Devonian sea. Along the entire route between Buffalo and the region of Arkona in southwestern Ontario, the Middle Devonian rocks are deeply buried. They finally crop out in the bluffs along the Ausable River in Ontario, but only about the middle third of Middle Devonian time is represented. Here, for the first time on the trip, we saw significant geographic variation across the bottom of the sea. The Arkona specimens all had eighteen rows of lenses while those of the same age in New York had only seventeen. Apparently the more primitive variety of *Phacops rana* was able to hang on for a longer period of time in the interior sea than on the margin.

Along the bluffs at Hungry Hollow on the Ausable River, rapid erosion is tearing down the soft, calcareous shales, creating slippery tracts of light gray mud. After being cemented nearly 400 million years in the Devonian seabed, clay particles rest here momentarily in their journey back to the modern sea. Yet even at this moment, the processes of fos-

silization go on. At our feet, amid loose Devonian fossils, lay the exquisite remains of mayflies stuck in the dried mud. But their temporary entrapment was to be as ephemeral in the reckoning of geologic time as were their lives by the daily reckoning of man.

Collecting our way up the shaly bluff, we kept finding the eighteen-row variety of *Phacops rana* until we reached a thick bed of limestone. Here, where the rocks changed abruptly, so did the trilobites. Suddenly, after two million years without change, the more primitive variety was supplanted by the more advanced seventeen-row trilobite already familiar to us from New York. Our closest scrutiny of the shale–limestone boundary turned up no specimens intermediate between the two varieties. Rather than supposing a sudden evolutionary jump between the two varieties, we concluded that the seventeen-row *P. rana*, already living in the east, simply migrated west as time passed. Thus the seventeen-row variety arrived in the seas of the continental interior some one or two million years after it had evolved closer to shore.

The next outcrops were in Michigan along the northern shore of Lake Huron, our westernmost stop in the Devonian sea. The shales and limestones seen on the lakeshore, in riverbanks, and particularly in large commercial quarries preserve a fairly complete record of Middle Devonian time. The quarries are particularly impressive; most of them, such as the quarry operation just north of Alpena, blast out huge amounts of limestone for cement making. We had mixed emotions whenever we saw a large dump truck hauling tons of fossiliferous limestone off to the crusher. On the one hand, we witnessed the daily destruction of thousands of fossils; on the other, without the quarrying, exposures of fossiliferous beds would be fewer, possibly even nonexistent, and we would end up with a much poorer picture of Middle Devonian life in Michigan.

From time to time in the past, what is now the southern peninsula of Michigan seems to have been cut off from complete communication with the seas elsewhere in the continental interior. As a consequence of this isolation, the organisms living within the Michigan Basin tended to diverge slightly from their relatives elsewhere. Here again, geographic isolation played an important role in evolutionary diversification.

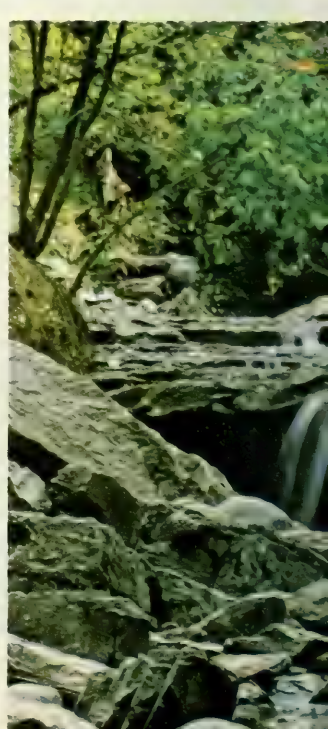
The Michigan Basin's peculiar environmental and geographic history directly affected *Phacops rana*. Another trilobite, *P. iowensis*, which is not a close relative, dominated the Michigan seas so completely that *P. rana* appears only sporadically and sparsely. *P. iowensis* seems to have lived mainly in the Michigan Basin throughout most of its existence, venturing outside of the area only at odd intervals. The Michigan Basin was its "turf," and *P. rana* a rival interloper. The different *P. rana* seen in Michigan, then, reflect occasional infiltration, rather than continual habitation there.

All *Phacops rana* specimens that we found in the lower half of Michigan's Middle Devonian sequence had eighteen rows of lenses in the eye. They were replaced by the seventeen-row variety, without any sign of gradual modification, in a thin unit corresponding in age to the thick limestone we found in Ontario. Thus far, the story of *P. rana* in both Ontario and Michigan was identical: persistence of the primitive variety over a span of time, with an abrupt and simultaneous switch to the seventeen-row type.

All but the very latest portion of the more recent half of Middle Devonian time is missing in Michigan. Rocks of latest Middle Devonian age crop out along the shores of both Lake Huron and Lake Michigan to the west. At Lake Huron, only *Phacops iowensis* is present, but along the shores of Lake Michigan a variety of *P. rana* with fifteen eye rows is present. These specimens are very similar, and presumably closely related to, those from the uppermost part of the sequence in eastern and central New York. It appears that again a wave of migration of an advanced eye variety invaded the seas of the continental interior from the east.

Although we sampled many other formations over the interior of the United States and along the southern Appalachians, the localities we have touched on here provided the key for understanding the evolutionary pattern of *Phacops rana* during its ten million years of existence. Many changes occurred in *P. rana* throughout its spatial and temporal distributions, but the changes in number of rows of lenses ultimately proved to be the most significant. The pattern was so clear that, given the age and location of a rock, we could predict which eye variety of *P. rana* might be present. Conversely, given a specimen of *P. rana*, we could position it in time and space simply by examining the eyes.

A very simple picture emerged. Twice the great continental sea dried up and extinguished the *Phacops* living in it. But twice a more advanced type of *Phacops* with fewer eye rows had evolved



on the eastern margin of the sea. Each time the continent was flooded, a different variety of *Phacops* spread west with the advancing sea.

All over the continental interior, the most primitive, eighteen-row variety of *Phacops* was present in the older half of the Middle Devonian. Meanwhile, the more advanced seventeen-row variety of *P. rana* was thriving in the east. We know the sea shrank away from the interior near the end of the first half of Middle Devonian times; this is clearly implied by the absence of sediments of this age anywhere in the Midwest. With the disappearance of their habitat, the primitive eighteen-row variant of *P. rana* simply vanished.

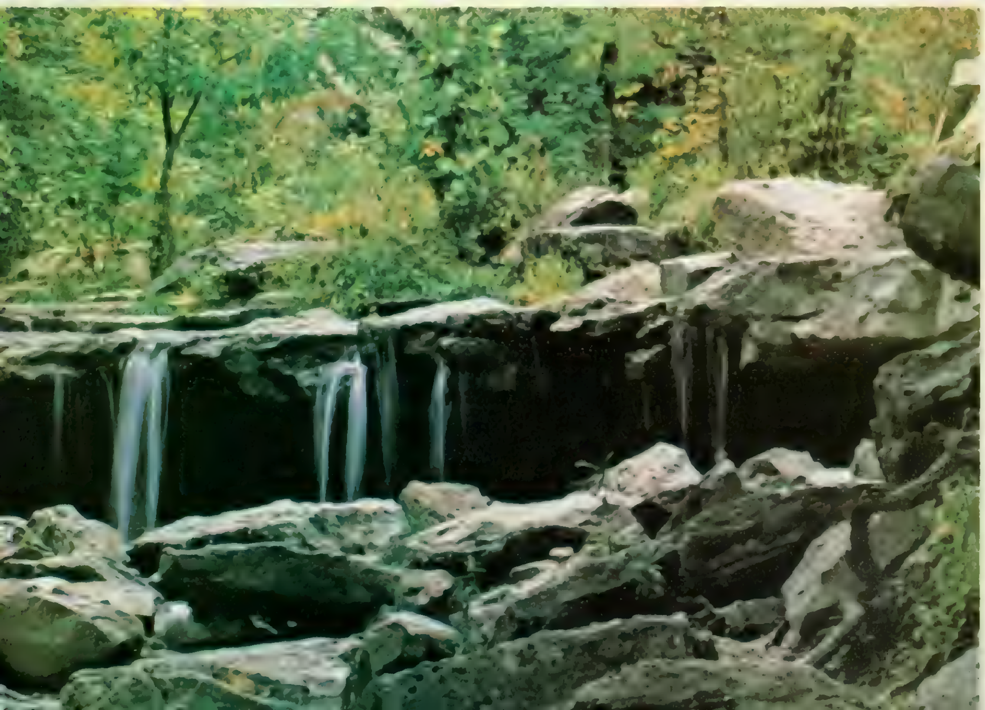
The Centerfield Sea, named for the Centerfield Formation of New York, reflects the first widespread inundation of the continent after this major withdrawal. This sea left traces in New York, the southern Appalachians, Ontario, Ohio, Michigan, and Indiana. Its sediments are easily identified by the distinctive fauna of corals and brachiopods, and everywhere that the remnants of this sea yield *Phacops rana*, only the seventeen-row variety is present. The conclusion must be that the advanced form is a migrant from the east.

This migrant, however, did not simply evolve after the extinction of its primitive relative to the west. On the contrary, we found it in very old rocks in New York and the Appalachians. For approximately two million years, the seventeen-row variety had lived in the east, unable to expand westward over the continental interior because of the continued existence of the eighteen-row variety already out there. Only after this primitive type became extinct could its relative gain a foothold in the western seas.

A similar episode—when the seventeen-row variety gave rise to the fifteen-row variety, again in the east—occurred near the end of the history of *Phacops rana*. This time, another, even longer withdrawal of the continental sea preceded the repopulation of the interior by a more advanced eye variant. Fifteen-row *P. rana* are known from the very latest Middle Devonian rocks of New York, Michigan, Wisconsin, and Iowa. Their story was short, however, for soon the sea disappeared once more, and by the time the continent was again flooded, *P. rana* had become entirely extinct.

Perhaps the most amazing feature of the entire *Phacops rana* story is its stasis—a persistence against change—through vast amounts of time. Contrary to popular belief, evolutionary change seems to occur infrequently, and usually in small, isolated populations in a short span of time. The bulk of a species' history is stasis, and there is no inexorable, progressive evolutionary march through time.

As this stream in southwest Ontario cuts its way toward the Ausable River, it exposes the history of a continent.



Nomads of the Niger

When the rains ease and the river recedes, a rhythmic migration affecting thousands of lives is set in motion

by Pascal James Imperato

The inland delta of the Niger River, a cyclical ecologic zone of some sixty thousand square miles, lies in the heart of the dry savanna and steppe of sub-Sahara west Africa. Its center is Lake Débo, a great, spider-shaped body of water midway between the towns of Mopti and Timbuktu in the Republic of Mali.

The delta was formed during the Pleistocene epoch when the Niger was two distinct rivers. The western Niger drained into a great inland sea, of which the delta, now composed of a complex zone of seasonal swamps, flood plains, rivers, and ponds, is all that remains. Due to climatic changes, the western Niger eventually flowed northeastward toward Timbuktu, where it rose high enough to travel over a bedrock barrier known as the Tossaye Sill and into the eastern Niger, which flowed south through present-day Nigeria and drained into the Atlantic Ocean.

In late May, the monsoon blows inland from the west, bringing enormous amounts of rainfall to Guinea and Sierra Leone where the Niger, Africa's third longest river, originates. Carried downstream, these waters swell the river, which floods in the inland delta. During the months of July, August, and September the eastward-moving monsoon drops more rain on the inland delta. When the delta is swollen, the river flows with ease and unlimited freedom into the great landscapes and splendid views that are the essence of Africa. At the high-water mark in November, the river is tremendously wide, and its waters overflow the surrounding plains, turning the delta into a shallow inland sea and giving it an immense and silent power.

With the passing of the crest in December and the beginning of the dry season, the waters of the inland delta recede, exposing low plains reminiscent of the dry, flat wheat fields of western Kansas. By April, the flood plains, completely dry, are covered by a luxuriant growth of borgus grass, *Echinochloa stagnina,* an excellent cattle fodder.

The cycle of rising and receding water, of flooded and exposed plains, goes hand in hand with another cycle involving thousands of Peul nomads with their millions of zebu cattle, goats, sheep, donkeys, and camels who migrate to Lake Débo during the dry season and return to their traditional territories during the wet season. The Peul descend from the plateau of the *sahel* in the northwest and the *seno* in the southeast. The *sahel* is a strip of semidesert immediately south of the Sahara, its name coming from the Arabic *sahil* meaning "shore," or "borderland." The *seno* is the high plateau country that lies along the delta's eastern periphery.

As the waters recede, herds grazing on the borgus grass at the edge of the plains move closer to the river, utilizing the water and grass resources as they proceed. At the same time, the Bozo fishermen on the Niger and Bani rivers move downstream with the lowering crest, following the migration of the fish toward Lake Débo. Merchants from Ghana and the Ivory Coast also come to Mopti, the commercial capital of

the inland delta, to buy the fish caught and dried by the Bozo.

From 1967 to 1969, I studied the nomadic way of life of the Peul and Bozo in order to plan comprehensive medical programs for them. As director of the smallpox eradication–measles control program in Mali, I had to plan, organize, and execute a vaccination program that would reach the entire population of the country.

At the time, the striking characteristic about smallpox in Mali was its almost exclusive occurrence in the central part of the country, the region of the inland delta. Because the nomads had never been reached by the mobile health services of the country, most of them were unvaccinated and, as a consequence, smallpox was endemic in Mali. If a detailed study of life and human society in the delta was not made, the battle against disease would be lost. Those without knowledge of the Peul assumed that there was very little social order among the nomads and that an attempt to find order in the supposed chaos of the migrations would be a waste of time.

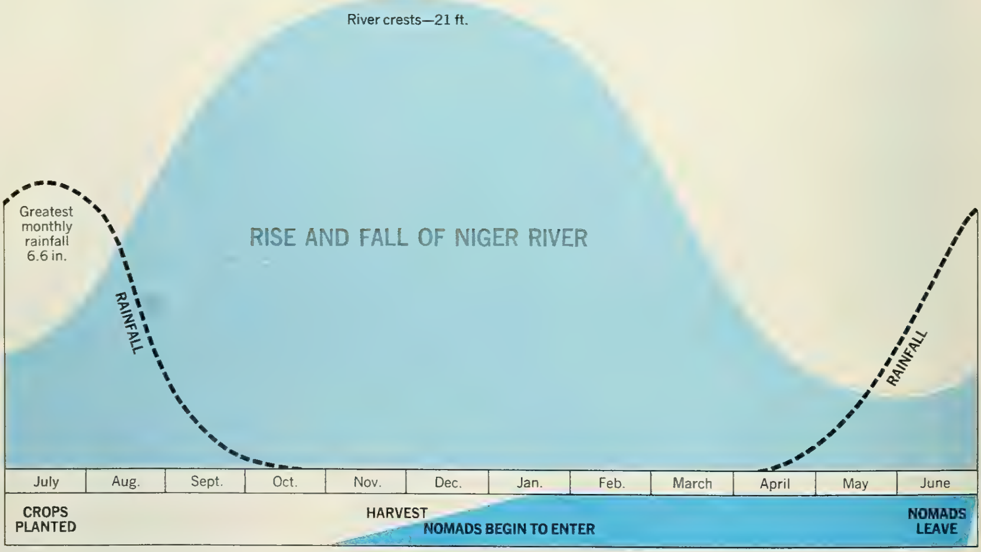
For the program to succeed, we had to discover the basic characteristics of the society: how people moved, their numbers and distribution, where they came from and where they went, whether it was a haphazard movement or an unchanging annual pattern. Even with the answers to all of these questions there was no guarantee that a health program directed toward the nomads would be successful.

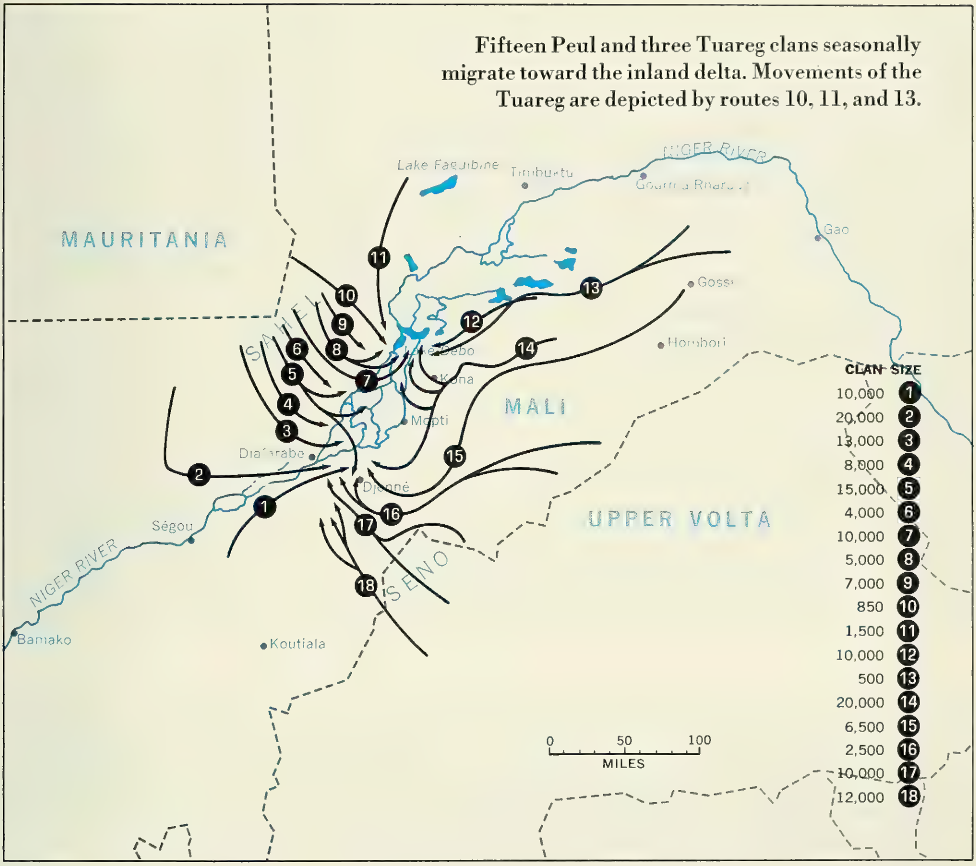
For several years I had witnessed the arrival of the Peul from the *sahel* and their herds at the town of Diafarabé, where the Niger widens and gives rise to its largest single branch, the Diaka. The first time I observed this event, I was impressed by the seeming chaos, and understood why it had been thought that the entire life pattern of the nomads was similarly chaotic.

Once a year, the cool air along the Diaka is charged with the noise of a drama being played out by thousands of Peul and their excited herds of cattle. It is a mass of men and animals, spilling over the orange-colored terraces of the river's steep banks, unrolling into the low skyline like an enormous bellowing dragon. The air is filled with smoke and the booming of nineteenth-century muskets. From one shore comes the hypnotic din of flutes and drums playing the same short tune over and over again. On the opposite shore, most of the Peul from the northwestern portion of the delta—herdsmen, chiefs, and nobles—wait for the signal to cross the river. After coming down from the *sahel,* the herds graze along the river bank for days while the Peul elders study religious artifacts in order to fix the day for the crossing. The date for this great event in the lives of the nomadic Peul depends upon the level of the river and upon other events in the Peul calendar. But it usually takes place in December.

The annual crossing of the river was organized by Cheikou Ahmadou, the first Peul emperor, in the early nineteenth century. It commemorates the passage of the herds from the harsh *sahel* into the rich grass-filled flood plains around the Niger. The Peul call this festival the *degal,* "the festival of return."

The Peul clans move into the delta in fifteen principal groups along traditionally established paths, or *burti.* On the average, the *burti* are a hundred miles long, but a few, such as those of the Dialloubé clan, are more than





Fifteen Peul and three Tuareg clans seasonally migrate toward the inland delta. Movements of the Tuareg are depicted by routes 10, 11, and 13.

two hundred miles long. Thus, in the annual cycle, most clans cover at least two hundred miles and some, four hundred. The actual distances walked, however, by both cattle and men are considerably longer because as they move forward, they frequently swing off the *burti* in circlelike fashion for a dozen miles or so, enabling them to take advantage of all the pastureland in the immediate vicinity of the path.

Approximately 163,000 Peul nomads participate in these seasonal movements, together with a million and a half cattle, a quarter of a million sheep, and half a million goats. Within the confines of the delta are another 250,000 Peul, semisedentary farmers and merchants who do not routinely take part in the transhumance treks, although they may do so occasionally. There are also large sedentary populations of farmers living on the periphery of the flood plains: an estimated 100,000 Bambara, 150,000 Bwa, 200,000 Minianka, 80,000 Marka, 250,000 Dogon, and 10,000 Songhoi.

I began my study along the southeastern periphery of the inland delta. In the rainy season, from April through September, it is a high green land of rolling hills and deep valleys covered with fields of millet and cotton and accented with baobab monarchs and shea butter trees. When the rainy season ends, the main cattle herds are organized into convoys of up to 15,000 head, known as *egguirgol*, which are supervised by the *amirou-nai*, or chiefs of the cattle. Each convoy is owned by a number of *weré*, large camps of several extended families, each with several thousand head of cattle.

Six major Peul clans move into the lower portion of the plains and nine into the upper portion. The convoys make the long slow march down the plateau through a hundred-mile belt of rich farmland toward the lower flood plains. At the same time similar convoys descend from the *sahel*, so that in effect there is a viselike convergence of nomads on the plains. The forward advance has to be gauged according to the availabil-

ity of grass and water on the plateau and by the state of the harvesting, which goes on at the same time or slightly before among the sedentary Bambara and Minianka farmers. The overwhelming consideration during this march is the optimal use of all available water and grass between the starting point and the final dry-season camps, which are either on the banks of the Niger or the Bani or on the shores of one of the great lakes of the delta.

By common agreement between the herdsmen and the farmers, the herds pass over the fields of the sedentary villages after the harvest is in. The cattle graze on the fields, thereby fertilizing them, for which the farmers pay the herdsmen with millet and corn. Temporary camps are established year after year on virtually the same fields and thus an intimate social and economic relationship is established between families of nomads and sedentary farmers. In some areas, farmers can predict with considerable accuracy the approximate time that "their nomads" will arrive. Disputes arise if the march begins before the harvest is in, a situation common during those years when insufficient rainfall prolongs the growing season and forces the nomads to move onto the plains early, well before the harvest.

Within the camps the huts are arranged in a semicircle; made of ten-foot-high stalks of millet with walls of plaited grass, they are shaped like American Indian wigwams.

When the first yellow of dawn breaks on the horizon in the *seno*, the valleys are full of singing finches and tolling doves. The soothing sound of water splashing up from a well, the muffled thuds of the women's calabashes as they carry the water back to their huts, the soft shuffling of human feet and babies' hungry cries fill the air. Puffs of white smoke from cooking fires drift over the wet ground. In the background one hears a steady stream of milk pouring into large yellow calabashes. Once the milking is completed, the cows, bulls, and calves move out of the camps in slow, shuffling processions, following the wide, well-beaten trails that skirt the fields of standing millet and ripened corn, and detour the villages of the Bambara farmers. The herdsmen walk up and down the columns with their wrists dangling in relaxed fashion over their shouldered clubs. They never shout at the cattle, but move them along with a constant, coughlike sound. The sheep and goats in the camps follow at a considerable distance, but the donkeys and their fuzzy colts remain behind. Watched by shepherds who take special care that they do not get into the cultivated fields, the herds of cattle pasture all day long.

The Peul are an extremely handsome people: the women soft, delicate, and graceful; the men tall and spare, with lean, smooth faces and deepset light-brown or, occasionally, blue eyes, set beneath long black lashes. No one really knows where these people came from; some maintain they originated in Ethiopia or in North Africa and others, that they are descendants of Jews who crossed the Sahara to Senegal centuries ago.

Their dress as well as their physical appearance makes them outstanding. The women's elaborate coiffures are masterpieces, studded with silver coins, sequins, white cowrie shells, red beads, great tiaras of amber stones, and gold rings. The men look more austere, especially the shepherds in their tunics and robes of coarse wool, either white or dyed a maroon color with the bark of the *neré* tree (*Parkia biglobosa*). They wear sandals and platter-sized straw hats rimmed with red leather and a peaked crown of the same. During the cold season they carry intricately woven wool blankets known as *khasa* over one shoulder and wear turbans and mufflers.

Their rigid form of Islam and austere way of life have always seemed out of step with the extravagance of their dress. One could not call the Peul an artistic

As the level of the Niger drops with the onset of the dry season, fish are trapped in the shallow waters of temporary ponds. Bozo fishermen then drive the fish into a small area and catch them with hand nets.

To celebrate the return to the delta, a ceremonial crossing of the Diaka River takes place at Diafarabé every December. A number of bulls painted with religious symbols are sacrificially slaughtered after they have crossed the river. Herdsmen swim with the cattle to guide them, but goats and sheep are taken across by canoe.

people, for they have not produced much in the way of a material culture such as sculpture and masks. Yet their artistic impulses are there, thwarted perhaps by religious sanction, but expressed in personal beautification.

For the Peul, cattle are the center of life; the needs of these animals shape and determine their way of life. The owner is the servant of the possession. His entire life is a cycle of finding water and grass for his cattle and of drinking their milk. Because of this, many say that the Peul are a nonproductive people, their lives a pattern of hard work and inefficiency in which only the cattle grow fat and healthy and enjoy the comforts of life. But a Peul loves to count his cows and bulls, to hear their bellowing, to rub their sleek hides, to recognize each one by sight, to have the scent of milk and manure in his nostrils, to be able to say that they belong to him.

As the herds get closer to the flood plains, they move in more compact groups until they pass through one of the traditional gateways into the inland delta. There are seventeen such passage points known as *gué;* each of these is under the control of a village that claims the pastureland surrounding it. Each *gué* is governed by a chief of the pasture who imposes a tax on each head of cattle passing through. Once the cattle actually enter the flood plains, they move through those areas of the plains that have been set aside for them by traditional convention with other clans. Sometimes conventions of this kind are not respected, either through malice, necessity, or ignorance, and the result may be armed conflict.

The plains are divided into

During the dry season, Bozo fishermen, above, frequent the port of Mopti to sell their dried fish and purchase supplies. The large, canopied canoes regularly transport passengers between Mopti and Timbuktu, a voyage of about eight days.

During the rainy season, when they are not herding cattle, some Peul nomads hire themselves out as goatherds to the Marka, an inland delta tribe. The Marka cultivate their crops at this time and goats must be kept out of the fields.

thirty-seven districts called *leydi*, which are the recognized communal property of given clans of Peul. Pasturing in them is governed by a complex weave of traditional verbal agreements and conventions established by Cheikou Ahmadou, one hundred and fifty years ago. Some areas of the flood plain, the *bourgou* as the Peul call them, have been disputed for more than a century, and each year witnesses a new series of disagreements between clans, especially if water and grass are scarce.

Since Mali became independent in 1960, the situation has been complicated by the government's declaration that the flood plains belong to everyone, including the Tuareg nomads who traditionally did not enter them in great numbers. Although the Peul still respect their traditional conventions, over the years the Tuareg have made increasingly deeper incursions into the pastureland. Even though fewer than 3,000 of them now enter the *bourgou* around Lake Débo, clashes between them and the Peul are very common, especially at the end of the dry season when most of the herds are bunched together in a desperate struggle for survival around the shores of the lake, where the last remaining water and grass are to be found.

In the flood plains, the Peul move their camps every two to four weeks, depending on the availability of grass and water. By April, those who make their final dry-season camps along the Niger and Bani and their tributaries set up their last campsites, where they remain until the rains begin. Those near Lake Débo, make their final camps on its shores in May and remain until June. Once the rains begin, the nomads and their herds move out of the plains with great rapidity. The soils of the alleuvial plains around Lake Débo become extremely muddy after even the first rainfall. The pastoralists leave the delta by the second rainfall, since a third heavy rain would trap them and their herds in a sea of impassable mud and water.

Those groups who come from the southeastern periphery return along their traditional *burti* toward the *seno*. While their entry into the plains is characterized by a slow and cautioned progression, their exit is a rapid dispersal. This

Bozo women, like the one above, always dress in simple clothing with few ornaments, but Peul women, right, wear ornate robes, jewelry, and headdresses. The size of a Peul woman's gold earrings is related to the wealth of her family. As a family's wealth increases through marriage and the accumulation of cattle and land, more gold is added to her earrings.

is because the grass of the *seno* during the rainy season is plentiful while the grass and water of the flood plains are limited and must suffice until the next rains. Once the herds arrive back in the *seno*, they are grazed around the permanent Peul villages, while the Peul themselves cultivate small fields of millet and sorghum.

In contrast to the Peul of the *seno*, those groups that enter from the northwestern periphery do not disperse upward toward the *sahel* along their *burti*. Rather, they graze their herds southwestward down the plains along the Niger and Diaka for about a month before moving into the *sahel*. This migration pattern is determined by the fact that rainfall and the grass it germinates are sparse in the *sahel* at the beginning of the rains. Thus, a northward dispersion is not possible immediately. Consequently, these groups of Peul must graze their cattle in the lower flood plains, where early rains replenish the land with water and grass. Before the mud becomes impassable, they move up into the *sahel* where by this time there is sufficient water and grass.

As the Peul adhere to the rhythm of the Niger for the sake of their cattle's health, so the 95,000 Bozo of the inland delta also follow the river's rhythm. Their movements along the river are determined by the migrations of fish, their dietary staple and economic base, which, in turn, move according to the rise and fall of the river. The seasonal migration pattern of the Bozo coincides with that of the Peul, the high crest causing a retreat upstream away from the center of the delta; and the falling crest, a gradual descent downstream toward Lake Débo.

Nomadism in the inland delta developed not only through an empirical response to the rhythm of the ecology but also through the intelligent planning of one man, Cheikou Ahmadou. In 1818 this man, a Muslim Marabout, mobilized the Muslim factions of

Continued on page 78

The Searc

or the Tasmanian Tiger

Do the continuing reports of sightings mean that this primitive carnivore is not extinct?

by Jeremy Griffith

The Tasmanian tiger is—or was—one of the largest marsupial carnivores in the world. It was once plentiful throughout Australia's island state of Tasmania, persistently tracking its

A few thylacines may survive as relict populations in the unsettled bush country that still covers much of western Tasmania.

prey in the abundant grassy plains and forests that characterized much of the territory prior to the arrival of white settlers. Early in this century, however, it seemingly disappeared, and the general opinion among zoologists is that the species is extinct.

The possibility that the tiger still survives in the island's remaining wild, and until recently impenetrable, bush country has inspired speculations not unlike those associated with the Loch Ness monster. The mystery surrounding the animal's continued existence has been compounded by frequent reports of sightings, although numerous expeditions have found few traces of it.

Convinced that there is a reasonable chance that at least a limited number of the nocturnal predators still prowl the game trails of the remnant wilderness, James Malley, a native bushman, and I have been conducting a thorough search for the animal. For the past six years we have scoured the bush for signs and followed up promising sightings. In spite of a paucity of funds and equipment, we have developed techniques to either live-capture an individual or otherwise verify its presence in an area.

The animal we are seeking has a superficial resemblance to a wolf, hence its other popular name—the Tasmanian wolf. It is also known as a hyena. A series of distinctive, blackish-brown stripes across the back, rump, and base of the tail is reponsible for its most colorful name: the Tasmanian tiger. But none of these is appropriate for *Thylacinus cynocephalus* (which means pouched dog with a wolf head), and such misnomers have contributed to many of the misconceptions and legends about this primitive, stealthy carnivore. Since it is the only species of its genus, *Thylacinus*, thylacine is a preferable name.

The thylacine's closest relative is the Tasmanian devil, *Sarcophilus harrisii*, a small bearlike marsupial that is also confined to Tasmania. Both animals have strong jaws, which they can open extremely wide. When thylacines yawn, the sides of their upper and lower jaws form an almost straight line, and they are said to be able to chop through the bones of any animal they catch.

Like other marsupials, the thylacine carries its young in a pouch on its belly. But unlike some, the pouch opens backwards, enabling the animal to run through thick scrub without hurting the offspring inside. The female's pouch encloses four mammae, and the male has a vestigial pouch. Because she has a shorter and broader head than the male, the female was sometimes referred to as a "bulldog tiger"; males were called "greyhound tigers."

The thylacine is a grizzled, tawny-gray or yellowish-brown

color, and measures about six feet long and two feet high at the shoulder. There is an accurate record of a seven-foot, nine-inch skin, measured from snout to tip of tail. While thylacines have been recorded from every region of Tasmania, it appears that they were more plentiful in areas where environmental conditions were the least severe. Based on the sketchy historical record of those who hunted or otherwise had contact with thylacines, the animals preferred broken country, with a combination of thick bush, rocky recesses, and open plain.

Thylacines evidently were fond of dry, dark places in which to "lie up" during the day. In fact, there are still places in the bush called "hyena rocks" and "tiger caves."

Most of what we know of the thylacine's habits is based on hearsay. Statements about its lifespan, breeding behavior, or spatial requirements are pure speculation. Almost exclusively nocturnal, even when they were abundant, they were rarely seen.

Anecdotal accounts from the 1800s and the early part of this century suggest that they hunt largely by scent, doggedly pursuing their prey for hours until it is exhausted. The kill is made by chopping into the victim's skull rather than by biting into the neck as a dog does. They feed primarily on blood, vascular tissue, and occasionally muscle, but there is evidence that they will also feed on carrion. The bulk of their prey consists of kangaroos, wallabies, small mammals, and birds.

Basically solitary animals, adults have been reported hunting in pairs and occasionally in what appeared to be family groups. Mothers accompanied by one to four young have been observed, and the offspring apparently stay with the mother until about twelve months old.

Their gait has been described as a shambling canter, and some observers maintain that when hard pressed, a thylacine hops like a kangaroo. But this seems improbable in view of the extreme posterior position of the hind legs and the forward position of the center of gravity.

Describing Benjamin, the last captive thylacine, which died in the Hobart Zoo in 1934, his keeper said: "He never made any sound, his bearing and silence was uncanny." The few references to the sounds made by thylacines mention a guttural, coughing bark while they are hunting and a whine, which may serve as a form of communication. Generally they have been called shy, furtive, and "morose." Adults were described by one zookeeper as being "difficult to tame, while the young are quiet and tractable, doing well in captivity provided they are given some small game besides meat." One old trapper told us that he kept a thylacine in a shed and that it thrived on fresh wallaby liver.

Bushmen have told us that tigers would follow them through the bush, and that they would also occasionally hear the animals around their camps at night. Thylacines are not aggressive toward man, and this behavior suggests that they have an inquisitive nature.

Fossil remains of thylacines have been found in many parts of Australia and even New Guinea. A mummified corpse, with fur and dried eyeballs still intact, was found in a cave in Western Australia in 1966. Carbon dating indicated that the animal had died somewhere between 2940 B.C. and 2240 B.C. Fossil evidence indicates that the thylacine disappeared from the mainland some 3,000 years ago, or soon after the introduction of the dingo. It is likely that the dingo, a more highly developed predator with habits similar to the thylacine's, competitively excluded it from the mainland. Tasmania and Australia were separated about 7,000 years ago and the dingo never reached the island.

The thylacine is difficult to domesticate, so the Tasmanian Aborigines did not befriend it. Nor did they hunt it—possibly because its elusiveness made it an unrewarding game animal in terms of the energy expended to kill one. So the thylacine was not persecuted until white sheep farmers appeared on the Tasmanian scene in the mid-nineteenth century.

Apart from the fossil record and local legend, little remains of its past other than a few bounty statistics, numerous stuffed museum specimens, some old movie footage of a caged specimen, and a few black-and-white photographs. The following is a collection of records and events that contain the essence of our factual knowledge of the thylacine's recent history:

1808: Surveyor general George Prideaux Harris gave the first scientific description of the species.

1832–1849: Records at the Van Diemen's Land Company of Surry Hills in northwestern Tasmania show that 147 sheep were killed by thylacines. In 1840 the company introduced a bounty for thylacine scalps.

1863: Naturalist J. Gould noted that the thylacine faced extinction.

1874–1887: Van Diemen's Land Company records show a total of 70 thylacines killed.

1878–1893: Records of a now defunct tannery show that a total of 3,482 thylacine skins were dispatched to a London firm, where they were made into waistcoats.

1888: The Tasmanian government introduced a bounty on thylacines because they were regarded as serious sheep killers. The last bounty was paid in 1909, and in the interim 2,184 were paid. One hundred and fifty-three, the largest number for any one year, were paid in 1900. A rapid decline followed until none at all were paid in 1910.

1888–1914: Van Diemen's Land Company records show that 84 thylacines were killed on their Woolnorth station during this period; again, the greatest number were killed in 1900, and a sudden decline followed.

1909: A newspaper advertisement offered "tiger shoots for visitors in search of fun!"

1910–1919: A Mrs. Roberts, who kept thylacines in her private zoo in Tasmania, shipped more than a dozen to zoos around the world, including London, Washington, and Wellington. From time to time specimens were kept in Australian zoos. The London

zoo has had at least a dozen thylacines, the last having been purchased in 1926; this specimen died in 1931. Australian naturalist David Fleay writes of this period: "Tigers were caught in box traps on bacon bait in the days when they brought in living specimens slung on poles to the late James Harrison of Wynyard—the man who acted in Tasmania as an agent for zoos all over the world."

1930: Officially, the last thylacine killed was shot at Mawbanna on the northwest coast. However, it is common knowledge in Tasmania that there were others killed after this date.

1934: Benjamin, the last thylacine in captivity, died in the Hobart Zoo.

The Griffith-Malley team is now concentrating its search in northeastern Tasmania, where reports of sightings have been on the increase.

1938: The Tasmanian government placed the thylacine on the list of wholly protected animals.

1938: Two naturalists, Sharland and Fleming, conducted short, month-long expeditions in search of thylacines in remote west coast areas. Sharland reports of one expedition: "We found tracks of thylacines every few miles—as the toe marks were well defined and the claws had been pressed deeply into the mud, the plaster casts when taken from the ground resembled dental plates with the claw impressions projecting like teeth." This is more likely a description of a forefoot print of a wombat, a badgerlike marsupial.

1945: David Fleay mounted a four-month expedition, revisiting the area Sharland surveyed in 1938. He sought to capture a pair by dragging scent trails to large box-type traps. Plaster casts of supposed thylacine tracks were brought out. Of these, two are wombat tracks, while the others are indistinct. In his report Fleay notes that snaring began intensively in this area in 1941, and that by 1946 there were "snare poles along every track and animal pad of consequence that we traveled." He mentions recent reports of sightings of thylacines by various bushmen, but no sightings were made by his party.

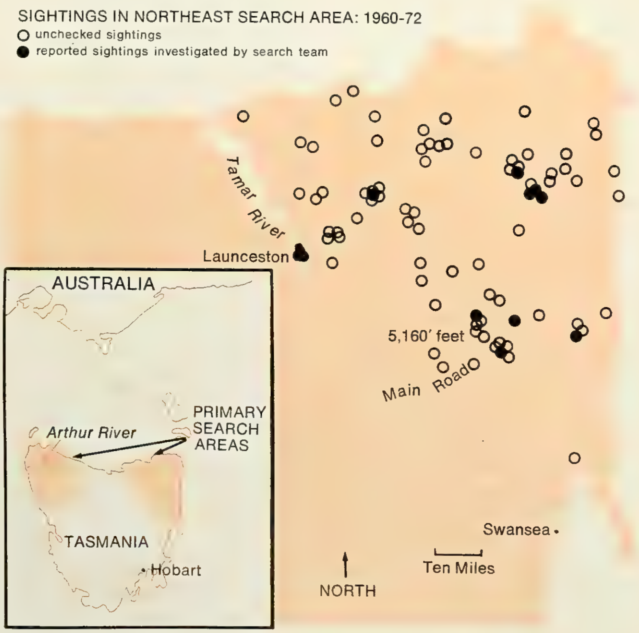
1958: Walt Disney sent a film team to Tasmania, which conducted an unsuccessful search.

1960: Sir Edmund Hillary, the first man to climb Mount Everest, joined a short, fruitless search.

1961: A thylacine was supposedly shot on the west coast. Mainly on the strength of this report, the Tasmanian Fauna Board launched a huge search. They relied on hundreds of snares set in the bush. But the type of trap used was a treadler snare, designed to be triggered by animals with long hind feet, such as the wallaby. Thylacines, because they normally walk only on their foot pads, are able to bypass the trigger-stick. Also, the idea of snaring areas without first finding other evidence of thylacines meant, in our opinion, that they had virtually no chance of success. The search was a fiasco.

These pieces of information suggest that the thylacine population was at a peak in 1900, then suddenly crashed and never recovered. It is widely thought that the crash was due to a disease outbreak in about 1910 that affected both thylacines and Tasmanian devils, but there is no direct evidence for this. Surprisingly, it does seem that until 1900—despite continued hunting and spreading civilization—thylacines were surviving in many areas.

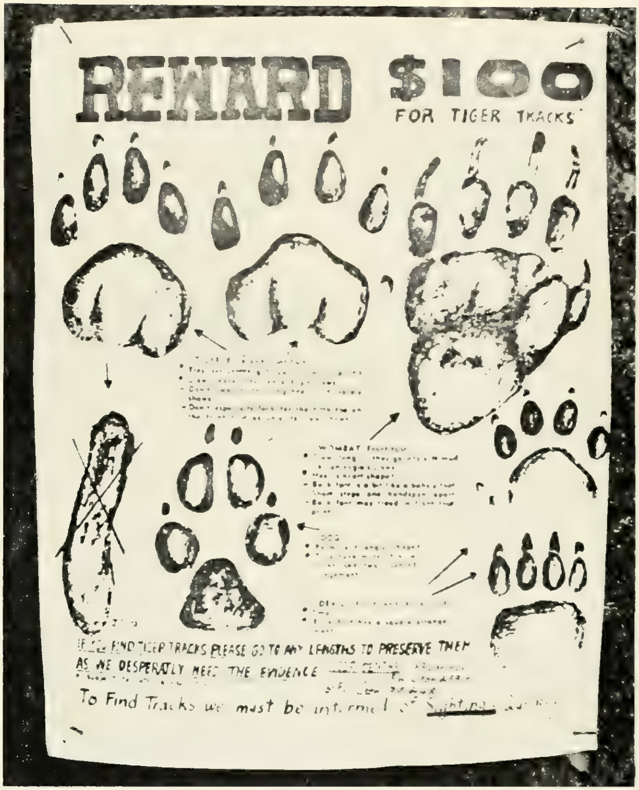
The failure of the thylacine population to recover after 1910 is probably due to several factors, acting singly or together. In many areas the original decimation of the animals was so drastic that their numbers were reduced to a point where a viable breeding population was no longer possible. Persecution by sheep farmers was severe and relentless. This extract from a letter from an old Tasmanian resident illustrates the effectiveness with which the thylacines were exterminated over a short period of time:



"Tigers were a proper problem with sheep in the Great Lake country. . . . Around 1900 some of the landowners . . . put together a tiger bank. . . . The bank was forty pounds in those days and they thought to pay two and six [25¢] per head. Well, two men built a rough brush fence and caught the tigers. They fetched in a load of tiger skins (about 300) and broke the bank in four months."

Approximately 15 million wallabies and opossums have been snared for the fur trade in Tasmania since 1923. Although thylacines were only occasionally caught this way, we think that the associated practice of leaving poisoned carcasses for Tasmanian devils, which habitually raided the snare lines, has been the primary cause for the complete disappearance of thylacines in many areas. Snaring is practiced in the winter months, when the animals' fur is thicker and they are not yet breeding. It is also at this time that thylacines would probably be ranging greater areas in search of food. They would then be prone to feed on whatever poisoned carcasses were left by the snarers. Possibly after only a few years of snaring and poisoning in an area, any thylacines would have been exterminated in this fashion.

This theory would account for the fact that over the last 30-odd years snarers have not accidentally caught a thylacine. Since 1930 the most promising sightings have, in fact, been in areas outside those of extensive snaring. Fleay came to a similar conclusion in 1946: "It is undoubtedly true that skinhunters . . . have played a very large part in bringing the thylacine so quickly to the brink of extinction." Fleay's suggestion for saving the thylacine was to "prohibit snaring in any form." It is a great pity that this advice was not followed, even in part, by the authorities. While snaring over the last few years has not been profitable and is now seldom practiced, some does still occur—along with poisoning—in remote areas where the thylacine could be expected to be making a final stand.



Reward notices have been posted in hopes of reducing the time between a sighting and the chance to check for tracks.

The failure of the population to recover may also be due to habitat alteration. Much of the plains country, especially the fields of button grass—a three- to six-foot sedge—were created by periodic burning. It is thought that the Aborigines originally burned the plains out of the bush, and the practice of "burning off" was perpetuated by the early snarers because it meant easier going and more green forage for game. These bushmen are fast disappearing, however, and today much of the land is badly overgrown and neglected. This has led to a reduction in game and thus, less food for thylacines.

Finally, it is reasonable to expect that a large primitive predator would find it difficult to adjust to the effects of man on its environment. We suspect that thylacines are not very adaptable and would be easily frightened by any disturbance.

Numerous sightings of thylacines have been reported in the past twenty years. At present we receive detailed reports of sightings about once a month. The problem with sightings is that we can never be sure of what was actually seen, and we often don't hear of a sighting in time to find tracks. However, there are a large number of sightings and the num-

ber has increased in recent years. Also, there seem to be more sightings in colder weather, when thylacines would be most likely to be moving about in search of food.

When searching for thylacines we have little hope of seeing them because of their nocturnal habits; therefore, we must rely on either tracking or attracting them. The latter method is inconclusive in proving their existence because if we are unsuccessful we are essentially no wiser. Because of the wet winters, effective bush work is restricted to the more clement months.

Another difficulty is the nature of the country itself. The bush of Tasmania's west coast, where part of our search is now concentrated, has a deservedly mean reputation, and some of it remains virtually unexplored and uncharted. When he joined a brief search for the thylacine in 1960, Sir Edmund Hillary commented that the country was among the most difficult to negotiate that he had ever encountered.

Typically, it is a wet, wild, and rugged wilderness, with rough, broken mountain ranges featuring occasional vertical peaks devoid of timber. Valleys and ravines are shrouded in forests of beech and primitive pines, and the rough plains of button grass complete the landscape. The bauera bush, with dense, vinelike branches, grows in the forest like a giant net. Twenty-foot-high tea trees and giant cutting grass add to the undergrowth, which, together with the high rainfall and rugged terrain, makes this wilderness so inhospitable. Animal life is not abundant, and thylacines—preferring the more open bushland of central and eastern Tasmania, which is now well settled by man—were never common here.

Walking in this region is often extremely difficult, and when surveying an area we follow game tracks wherever possible. We seldom encounter wildlife and it is only by studying game trails that we learn about any animal movements. We expect that a thylacine, unless disturbed, would have regular habits and that we would pick up its tracks at some point if it were hunting in the area under search.

We have found that such tracking requires a lot of experience. The only guide we have to thylacine footprints comes from studying the feet of museum specimens and from drawings that were made by R.I. Pockock of London in 1926.

Having been into every likely corner of Tasmania, we appreciate how elusive a few thylacines could be in that country. That we haven't as yet found conclusive evidence of thylacines does not necessarily indicate that they are extinct. Rather, it illustrates the enormity of our task.

Undoubtedly, some thylacines were extant at least until 1950, and we are confident that there are areas where they have survived the last twenty years. Conditions in the southwest are too severe, and the central plateau and midwestern regions have been extensively snared. Financial support from the Australian Conservation Foundation enabled us to survey the most promising of the remote parts of these areas two years ago, and we found no sign of thylacines. It is in the areas bordering the central plateau of Tasmania, the Arthur River in the northwest section, and in the northeast corner of the island that we hold our greatest hopes. Excellent reports of sightings have come from all of these areas. The most recent plaster cast of what we consider a definite thylacine footprint was taken in 1961 at Mawbanna, near the Arthur River, the same place where officially the last thylacine was shot in 1930. We have also recently found indistinct tracks that we believe were made by a thylacine near the same site.

We anticipate that it may take many more months to find conclusive evidence of thylacines, but to complement our system of tracking, we have developed an automatic camera-monitoring system to place alongside likely trails. Results in the last months show these monitors to be highly reliable, and we have obtained photographs of wallabies, Tasmanian devils, and other animals.

For years we have been literally beating our heads against the bush in what some have termed a quixotic quest. Our justification has been the concern, shared by zoologists and naturalists, over the Tasmanian tiger's survival. With growing local support and a limited amount of financial assistance from the Australian government, we have covered hundreds of square miles in the pursuit of thylacines, checking out as many

sightings and leads as possible. Our experiences in the field lead us to believe the trail is at least getting warmer.

James Malley and I believe the thylacine must be found soon if it is to be saved. The last pockets of wilderness will soon be cleared for mining, timbering, and hydroelectric ventures, destroying the remaining thylacine habitats. Also, if there is another outbreak of disease among Tasmanian devils, it could well affect any remaining thylacines. And not more than five miles from where we believe we tracked a thylacine, a notice on a fence post warned of the use of 1080 rabbit poison in the area. We are powerless to help thylacines unless we can find them and assess their predicament; the alternative is that an uncertain case of extinction will become certain.

A pre-1930 captive thylacine stands with one heel on the ground. This posture is not typical and may be due to a foot injury.

Nomads of the Niger

Continued from page 68

the Peul and then usurped the throne of the fifteenth-century Peul Diallo dynasty, freeing the Peul of their vassal position in the Bambara kingdom of Segou. He then set up a theocratic state whose capital was Hamdallaye, a town he had built on the south-eastern periphery of the flood plains. He consolidated the entire inland delta under his power and divided it into six regions, Farimake, Kounari, Seno, Macina, Sebera, and Pignari. Although these names do not appear on modern maps of the inland delta, they are the names still used by the Peul and Bozo. Cheikou Ahmadou ordered the Peul to build permanent villages to which they would return during the rainy season. This first attempt at semisedentation of nomads in the delta was a success, and the villages built under Cheikou Ahmadou still stand on the hillocks that lie scattered along the periphery of the flood plains.

He reorganized the movements of the nomads in and out of the inundation zone, taking into consideration the grass and water available for the herds of the various clans. It was the first attempt at range control in this part of the world, and the patterns established by Cheikou Ahmadou still exist in most of the delta.

Cheikou Ahmadou declined the title of king and took instead that of *cheikou*, or "spiritual guide." Prior to overthrowing the Diallo dynasty, he had traveled more than a thousand miles to Gobir, in what is now northern Nigeria, where he met the Muslim reformer Usman Don Fodio. When Cheikou Ahmadou returned to the inland delta with several followers, he was full of Don Fodio's zeal for Islamic reform and launched religious crusades against the animist practices of the Peul; against the domination of the animist Bambara, whom he considered to be inferior fetish worshipers; and against the Muslim religious establishment. The eventual religious excesses of Cheikou Ahmadou's priest-king rule drove many of the animist Peul unwill-

ing to accept Islam out of the inland delta. They migrated to the banks of the Niger below Gao where their descendants still live.

The animist Peul believe in an omnipotent and immortal spirit called Gueno. The guardian on earth for cattle, acting on behalf of Gueno, is a supernatural personality named Tyanaba. According to Peul mythology, he lives in the depths of Lake Débo with an immortal herd of cattle, which belong to Gueno.

Inherent in this religion is the belief that cattle are not simply wealth on the hoof, but rather relatives and totems. While the Muslim Peul explain their migration to Lake Débo on the basis of Cheikou Ahmadou's ordinances and on tradition based on necessity, the animists explain that they go there so that their herds can copulate with Tyanaba's supernatural herd, which is believed to come up out of the lake at night.

The complexity of life in the inland delta of the Niger is a beautiful sequence of natural and human events, the one following the other in a masterful plan of precise timing. Our success in bringing modern health services to the nomads lay in fitting our plan into this sequence. Because we learned that nomads live, not in chaos, but within a defined pattern, we were able to vaccinate more than one million inhabitants of the inland delta against smallpox in 1968 and 1969; and by the end of 1969 smallpox had been entirely eradicated from Mali. Over the same time period, measles was reduced by 80 percent.

The cyclical nature of the rising and falling of the river has determined for centuries when, where, and what men will do. And then, more than a century ago, Cheikou Ahmadou formed a plan for land use that no man since has been able to better, a plan not just for survival, but for prosperity.

It all begins with a drop of water on the faraway slopes of the highlands in Guinea. A river rises and overflows its banks, grass flourishes, the waters recede, and the herdsmen descend from their plateaus while the fishermen ride the falling crest. It is as simple and complex as that. ■

The Mysterious Fall of Nacirema

Continued from page 18

The object was designed to eliminate most sounds from the outside and to fill the interior with a hypnotic humming sound when the machine was in operation. This noise could be altered in pitch and intensity by the manipulation, through simple mechanical controls, of an ingenious mechanism located outside the operator's compartment. This mechanism also produced a gaseous substance that, in a small area, could change the appearance of the air in a manner similar to the permanent plant installations.

In the early stages of the symbol's development, this was probably only a ritualistic performance since the production plant was small and was fueled by a small tank. This function, however, may have been the primary reason for the cult's symbol: to provide each family with its own device for altering the environment by giving it a private microuniverse with a system of producing the much desired air-changing reagent.

The complete machined piece was somewhat fragile. Our tests of the suspension system indicate that it was virtually immobile on unimproved terrain; by all of our physical evidence, its movement was restricted to the surfaced steerts that the Nacirema had built to geometricize the landscape.

We are relatively certain that a specially endowed and highly skilled group of educators was employed to keep the importance of these enclosed mobile devices constantly in the public eye. Working in an as yet unlocated area that they referred to as Euneva Nosidam, these specialists printed periodical matter and transmitted electronic-impulse images to boxlike apparatus in all homes.

While some of the information was aimed at describing the appearance and performance characteristics of the various kinds of machines, the greatest portion of the material was seemingly aimed at something other than these factors. A distinguished group of linguists, social psychologists, and theologians, who presented the

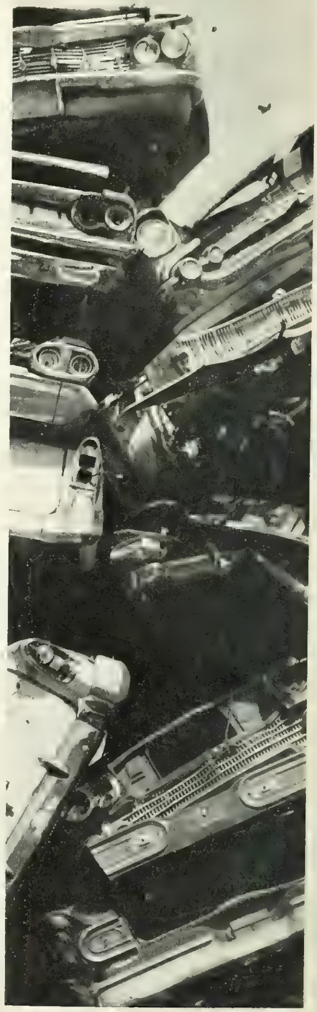
principal symposium at our most recent anthropological conference, offered the hypothesis that the elibomotua symbols, also known as racs, replaced the processes of natural selection in the courtship and mating rituals of the Nacirema. Through unconscious suggestion, which derived from Euneva Nosidam's "mcnahulesque" materials, the female was uncontrollably driven to select her mate by the kind of elibomotua he occupied. The males of the culture were persuaded to believe that any handicap to masculine dominance could be overcome by selecting the proper cult symbol. In this way, the future of the race, as represented by Nacirema culture, was determined by unnatural man-made techniques.

The symposium was careful to point out that we have not yet uncovered any hard evidence to show whether or not this cultural trait actually had any effect on the race or its population growth. We have found, however, one strange sculpture from the Pop Loohcs depicting a male and female mating in an elibomotua's rear compartment, indicating a direct relationship. The hypothesis has the virtue of corresponding to the standard anthropological interpretations of the Nacirema culture—that it was ritual ridden and devoted to the goal of man's control of the environment.

Further evidence of the Nacirema's devotion to the Elibomotua Cult has been discovered in surviving scraps of gnivom serutcip. Some of these suggest that one of the most important quasi-religious ceremonies was performed by large groups who gathered at open-air shrines built in imitation of a planetary ellipse and called a kcartecar. There, with intensely emotional reactions, these crowds watched a ritual in which powerful gnicar racs performed their idealized concept of the correct behavior of the planets in the universe. Apparently, their deep-seated need for a controlled environment was thus emotionally achieved.

The racs did not hold a steady position in the planetarium, but changed their relationship to the other racs rather frequently. Occasionally a special ritual, designed

to emphasize man's power over his universe, was enacted. On these unannounced occasions one or more of the planet symbols was destroyed by crashing two of them together or by throwing one against a wall. The emotional pitch of the worshipers rose to its highest level at this moment. Then, on command of the high priest of the ceremony, all the gnicar racs were slowed to a funereal speed and carefully held in their relative positions. After an appropriate memorial period honoring man's symbolic control of the



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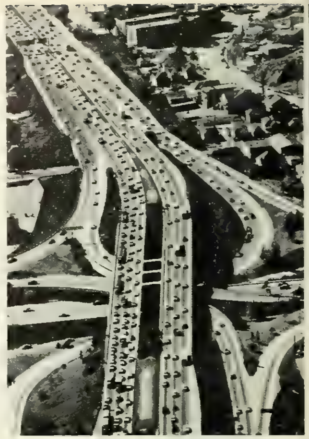


universe, the machines were given the signal to resume their erratic speeds and permitted to make unnatural position changes.

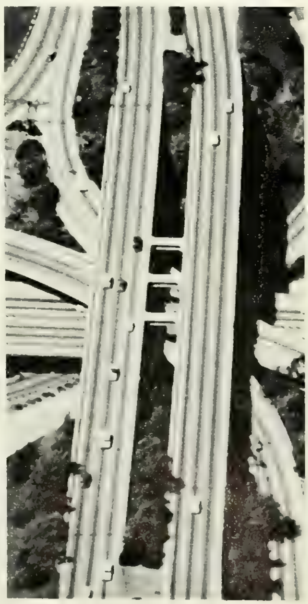
We can only speculate on the significance of this ritual, but it seems reasonable to conclude that it served as an educational device, constantly imprinting in the individual the society's most important values.

Many of the findings of archeological explorations suggest that these symbols of universal power took up a large portion of the time and energy of the Nacirema society. Evidence indicates that a sizable portion of the work force and enormous amounts of space must have been devoted to the manufacture, distribution, and ceremonial care of the devices. Some of the biggest production units of the economy were assigned this function; extensive design laboratories were given over to the manipulation of styles and appearances, and assembly lines turned out the pieces in serial fashion. They were given a variety of names, although all of those made in the same time period looked remarkably alike.

Every family assumed the responsibility for one of the machined pieces and venerated it for a period of two to four solar cycles. Some families who lived in areas where a high quality of life was maintained took from two to four pieces into their care. During the time a family held a piece, they ritually cleansed it, housed it from the elements, and took it to special shrines where priests gave it a variety of injections.

The Nacirema spent much of their time inside their elibomotuas moving about on the steerts. Pictures show that almost everyone engaged, once in the morning and once in the evening, in what must have been an important mass ritual, which we have been unable to decipher with any surety. During these periods of the day, people of both sexes and all ages, except the very young and the very old, left their quarters to move about on the steerts in their racs. Films of these periods of the day show scenes analogous to the dance one can occasionally see in a swarm of honeybees. In large population centers this "dance of the racs" lasted for two or three hours. Some students have suggested that since the swarm dances took place at about the time the earth completed one-half an axial rotation, it may have been a liturgical denial of the natural processes of the universe.

Inasmuch as we are reasonably certain that after the rite most of the adults and all of the children left the racs and were confined inside man-made structures variously called loohcs, eciffos, tnalps, or emohs and, when released, went immediately to their racs and engaged in the next swarming, the suggestion may be apropos. The



ardent involvement of the whole population from ages 6 through 65 indicates that it was one of the strongest mores of the culture, perhaps approaching an instinctual behavior pattern.

It should also be mentioned that, when inside their racs, people were not restricted to their ottehgs, but were free to go anywhere they chose so long as they remained on the steerts. Apparently, when they were confined inside a rac, the Nacirema attained a state of equality, which eliminated the danger of any caste contamination.

These, then, to the best of our present state of knowledge, were the principal familial uses of the Elibomotua Cult symbols. After a family had cared for a piece long enough to burnish it with a certain patina, it was routinely replaced by another, and the used rac was assigned to a gallery keeper, who placed it on permanent display in an outdoor gallery, sometimes surrounded by trees or a fence, but usually not concealed in any way. During their free time, many persons, especially those from the ottehgs of the lesser sorts, came to study the various symbols on display and sometimes carried away small parts to be used for an unknown purpose.

There seems to be little doubt that the Cult of the Elibomotua was so fervently embraced by the general population, and that the daily rituals of the rac's care and use were so faithfully performed, that the minute quantities of reagent thus distributed may have had a decisive effect on the chemical characteristics of the air. The elibomotua, therefore, may have contributed in a major way toward the prized objective of a totally man-made environment.

In summary, our evaluation of both the Nacirema's man-made environmental alterations and the artifacts found in their territories lead us to advance the hypothesis that they may have been responsible for their own extinction. The Nacirema culture may have been so successful in achieving its objectives that the inherited physiological mechanisms of its people were unable to cope with its manufactured environment. ■

But with a Cloud of Steam

In the future the earth may be more of a hellhole than Venus is now: enveloped in a cloud of steam under an atmospheric pressure 300 times that of current levels, the kind of pressure now found only 10,000 feet down in the ocean. At the same time, Mars may become positively balmy and very attractive to any terrestrial survivors.

Thus do Carl Sagan of Cornell University and George Mullen of Mansfield State College conclude a discussion in *Science* of the evolution of the atmospheres and surface temperatures of earth and Mars.

In essence, the authors ran the film of solar luminosity and the atmospheric evolution of Mars and the earth first backward and then forward in time from the present. The sun has been getting hotter with time and will get much hotter in the future. The earth, because of greenhouse effects, has been warming even faster. Radiation coming from the sun at visible and short infrared wavelengths passes through the atmosphere and warms the earth's surface. The surface radiates this heat back toward space at longer infrared wavelengths, but certain atmospheric constituents are opaque to these wavelengths and the radiation is absorbed and thus kept on earth. At the present time, for example, the greenhouse effect is keeping the earth 90 to 100 degrees warmer than it would be as a result of solar radiation alone. For Venus this difference is much greater.

By itself, the luminosity of the sun would not have brought the surface temperature of the earth above the freezing point of seawater until 2 billion years ago, or even less. But geologic evidence places running water on the earth at least 3.2 billion years ago, and fossilized blue-green algae, which presumably required liquid water, also date from then.

By a long process of elimination, Sagan and Mullen have determined that ammonia in the early terrestrial atmosphere would have produced the same greenhouse effect that water vapor and carbon dioxide do now. (It also would have been useful as a biological precursor.) The same ammonia greenhouse effect could have given Mars a surface temperature near or above the freezing point of seawater within a billion years of formation. Life may have arisen on Mars at the same time it did on earth. But because the gravitational field of Mars is much weaker than the earth's, hydrogen released in the breakup of water molecules would have escaped into space far more rapidly. Free oxygen would have been locked up by chemicals on the surface. Bodies of water many tens of feet deep that formed in the first billion years would have disappeared in a geologically short time.

The authors note that any organisms that evolved on Mars during this early period of warmth and water would have faced an increasingly cold and dry environment, but it is not impossible that some adapted.

The presence of liquid water early in the planet's history would also account for existing surface features that look so much like the results of erosion and so unlike features on the moon.

In another 3 to 5 billion years, the sun is expected to be half again as luminous as it is now. As surface temperatures on earth rise, more and more water vapor will end up in the air, trapping more and more of the solar radiation and raising the temperature faster and faster, until finally the earth will experience a runaway greenhouse effect such as now exists on Venus. At that point the earth's surface will be a high-pressure steam bath.

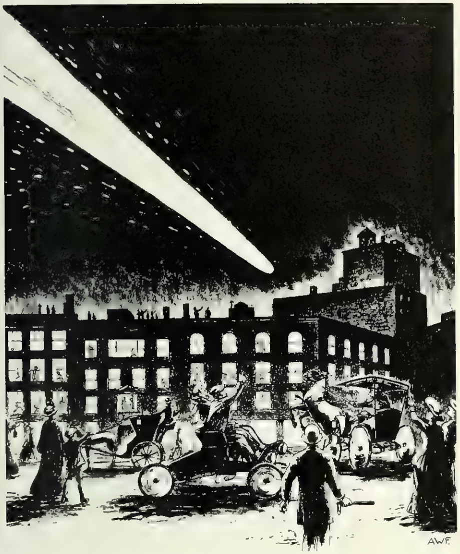
But the same increase in solar luminosity will bring Mars back to clement temperatures. "If there are any organisms left on our planet in that remote epoch," the authors conclude, "they may wish to take advantage of this coincidence."

Note to our Readers: Because of a printing error, the Sky Map in our November issue was garbled. The star labels and moon positions were correct, but the sky itself was turned 180 degrees. *Natural History* regrets the error and the confusion it caused.

The Search for Planet X That trans-Plutonian planet "discovered" by analysis of the perturbations of Halley's comet has not yet turned up in anybody's telescope. It is either smaller than predicted, not where it was predicted to be, or it simply isn't.

Each night during June and July a three-man team at the Royal Greenwich Observatory in England photographed that part of the sky where the tenth planet was predicted to be. Plates from different nights were then placed in a machine that very rapidly presented to the eye first one plate, then the other. Any object moving from night to night, as a planet would, would appear to blink first at one position, then at another. Even though the plates covered an area 3.5 degrees on all sides of the predicted position, nothing blinked. Writing in *Nature*, the team said they would have seen the planet if it were magnitude 16 or brighter, and certainly would have seen it at the predicted magnitude 14.

Last April, in the *Publications* of the Astronomical Society of the Pacific, Joseph L. Brady of the Lawrence Livermore Laboratory at the University of California proposed the existence of the planet. He



Halley's comet, which caused a stir when it last approached the earth in 1910, is deviating slightly from its calculated orbit. The difference may be caused by the gravitational attraction of a large unknown planet far beyond the orbit of Pluto.

argued that a planet at twice the distance of Neptune with a mass three times that of Saturn and an orbit inclined 120 degrees to the ecliptic was causing measurable changes in the orbit of Halley's comet. Or, more precisely, he showed that the difference between where Halley's comet was predicted to be at any given time, and where it was actually found, could be explained almost perfectly by the gravitational effect of such a planet. Adding the planet eliminated 93 percent of the discrepancies.

Postulation of the tenth planet would also clear up similar discrepancies in the orbits of two other long-period comets, Olbers and Pons-Brooks.

The current British search was not the first for a trans-Plutonian planet. After the discovery of Pluto in 1930, Clyde W. Tombaugh at the Lowell Observatory spent 16 years looking for such a planet. Pluto did not seem large enough to account for orbital discrepancies in the immediately sunward planets, leading to speculation that some unknown planet other than Pluto was responsible for their perturbations.

Brady estimates that from 1929 to 1946, Planet X moved from declination 60 degrees north to 67 north. In that same part of the sky, Tombaugh ended his search at 60 north.

Now the optical search is on again, and again the trans-Plutonian planet is proving elusive. Maybe it just isn't, after all.

A Radio Supernova Radio astronomers were knocked right out of their chairs last September when an old familiar radio source suddenly flared up to 1,000 times its normal intensity. By October four more outbursts had been observed, and Cygnus X-3 was famous.

The source, X-3 in the northern constellation Cygnus, has never been seen optically because it lies thousands of light-years away on the edge of the galaxy and numerous dust clouds between us and the source attenuate the light. It has long been known as a weak, variable source to radio astronomers, however, and satellites have measured its X-ray flux.

By examining the outburst radiation at different frequencies, the radio astronomers put together a spectrum that reveals something of the nature of the source. It best fits the model of an expanding cloud of protons and electrons moving at speeds close to that of light in a magnetic field. As such particles spiral along magnetic lines of force, they emit radiation exactly like that seen from Cygnus X-3. This is known as synchrotron radiation, and until now has only been associated with supernovae and pulsars. Thus, Cygnus X-3 is coming to be known as a "radio supernova."

As P.C. Gregory of the Algonquin Radio Observatory in Ontario put it in *Nature*, he and his colleagues had recorded "the most impressive outburst ever witnessed by radio astronomers." He suggests it is most unlikely that Cygnus X-3 is unique in this respect and that many radio objects in our galaxy may be violently variable, a feature that has been missed in conventional radio surveys.

The discovery may not mark the discovery of a new class of objects, but it certainly marks the discovery of a whole new class of activity by celestial objects. The excitement since September has been equivalent to that after Anthony Hewish announced the first pulsars in 1968. Everybody who had access to a radio telescope tuned in on Cygnus X-3, resulting in an equally impressive outburst of papers on the subject. *Nature*'s physical sciences edition of October 23 alone carried more than twenty. A new chapter for future textbooks is in the making.

Celestial Events

by Thomas D. Nicholson

The Moon First-quarter occurs on December 13, so the waxing gibbous moon will be well up in the sky at sundown during the week following midmonth. It becomes full on the 20th, when the moon is in the sky all night. Thereafter, it rises later each night and remains till dawn, as a waning gibbous moon until last-quarter on the 27th, and as a waning crescent, rising after midnight, until month's end. On the morning of New Year's Day, the late crescent moon will form an interesting arrangement in the dawn sky with brilliant Venus, reddish Mars, and the equally reddish but brighter star Antares in Scorpius.

Stars and Planets This is the time of year when the brightest stars of the sky are visible in the early evening. Just after sundown, you can still see the brightest summer stars low in the west: Altair and Vega close to the horizon; Deneb higher, with the Northern Cross below it, standing erect over the horizon to the left of west. Meantime, the closely grouped and brilliant winter stars are rising in the east and southeast. Orion is well above the horizon at dusk, and Sirius, the brightest of all stars we see, rises shortly after twilight ends.

Both Jupiter and Saturn are evening stars during the period. Jupiter is in Sagittarius, low in the southwest at dusk and difficult to observe. Saturn is in Taurus, just to the left of the Pleiades and the reddish star Aldebaran. It should be very easy to find from early evening, when it is high in the southeast, until dawn, when it is setting in the west.

In the morning sky, Saturn will be in the west, setting with Taurus; Venus and Mars will be low in the southeast, rising just about dawn. The latter two planets are moving into Scorpius, approaching the bright reddish star Antares. Venus passes the star and begins moving away from it on Christmas Day, and Mars catches Antares on January 12. Mercury is in favorable position for about a week at mid-December, when it may be seen low in the southeast just after dawn.

Meteors Two meteor showers reach the earth during the period, the Ursid shower on December 22 and the Quadrantid shower on January 3. The Ursids are faint and not very productive (15 per hour), and the brightness of a waning gibbous moon after midnight will interfere. The Quadrantids reach a short, sharp maximum, and sometimes produce up to 40 meteors per hour, but not reliably. At least the nearly new moon will not hamper observations.

December 19: The moon is at perigee, nearest earth. Saturn and the moon rise close together this evening and remain close during the night.

December 21: The sun arrives at the winter solstice at 1:13 P.M., EST, and winter commences in the Northern Hemisphere.

December 25: Venus is in conjunction with Antares.

December 31: The moon is at apogee, farthest from earth.

January 1: Mars is above the crescent moon this morning, and Venus is well to the left. The reddish star Antares, brighter than Mars, is between the two planets.

January 2: Earth is at perihelion, nearest the sun. The crescent moon is much closer to Venus this morning, while Mars is higher and well to the right.

January 10: Jupiter enters the morning sky.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:20 P.M. on December 15; 9:20 P.M. on December 31; and 8:15 P.M. on January 15; but it can be used for about an hour before and after these times.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PERSEUS
Almach
ANDROMEDA
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Enif
Mirach
PEGASUS
Markab
GEMINI
December 20
January 15
Saturn
TAURUS
ARIES
PLEIADES
December 17
Hamal
January 12
PISCES
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January 9
Aldebaran
Bellatrix
ORION
CETUS
AQUARIUS
Saiph
Rigel
Sirius
ERIDANUS
Diphda
LEPUS

A Four-Eyed View of Africa

THE TREE WHERE MAN WAS BORN, text by Peter Matthiessen. THE AFRICAN EXPERIENCE, photographs by Eliot Porter. A dual volume. *E.P. Dutton & Co. $17.50; 247 pp., illus.*

The publisher states on the dust jacket: "The idea for this book was to engage a writer and a photographer with the combined talents to create a book unlike any other on the human and natural history of East Africa. . . . Usually working apart, and with no attempt to cover exactly the same terrain . . . to create two parallel statements. . . ." The idea of separate identities for the text and photographs has been carried all the way by giving each a different book title. Both are mixed together in one volume. How does this work? Not very well. The photographs are overwhelmed by the text and neither contributes enough to the other.

No single photographer could have equaled the rich and varied experiences of Matthiessen during his three trips to Africa in 1961, 1969, and 1970, unless it were Matthiessen himself taking the pictures. He has ranged almost everywhere and in the most unlikely places. His writing on African prehistory and man's origins is outstanding. His passion for the beauty of nature has an unlimited horizon, albeit at times described in purple prose. The sketches of some of the men he was with, notably Iain Douglas-Hamilton and Peter Enderlein, rival those in Somerset Maugham's *A Writer's Notebook*. Matthiessen tackles the Mau Mau rebellion, and brings today's black versus white drama into focus with the succinct remark: "Whites are needed but not wanted." Even a naturalist's wife about to have a premature delivery is grist for his mill.

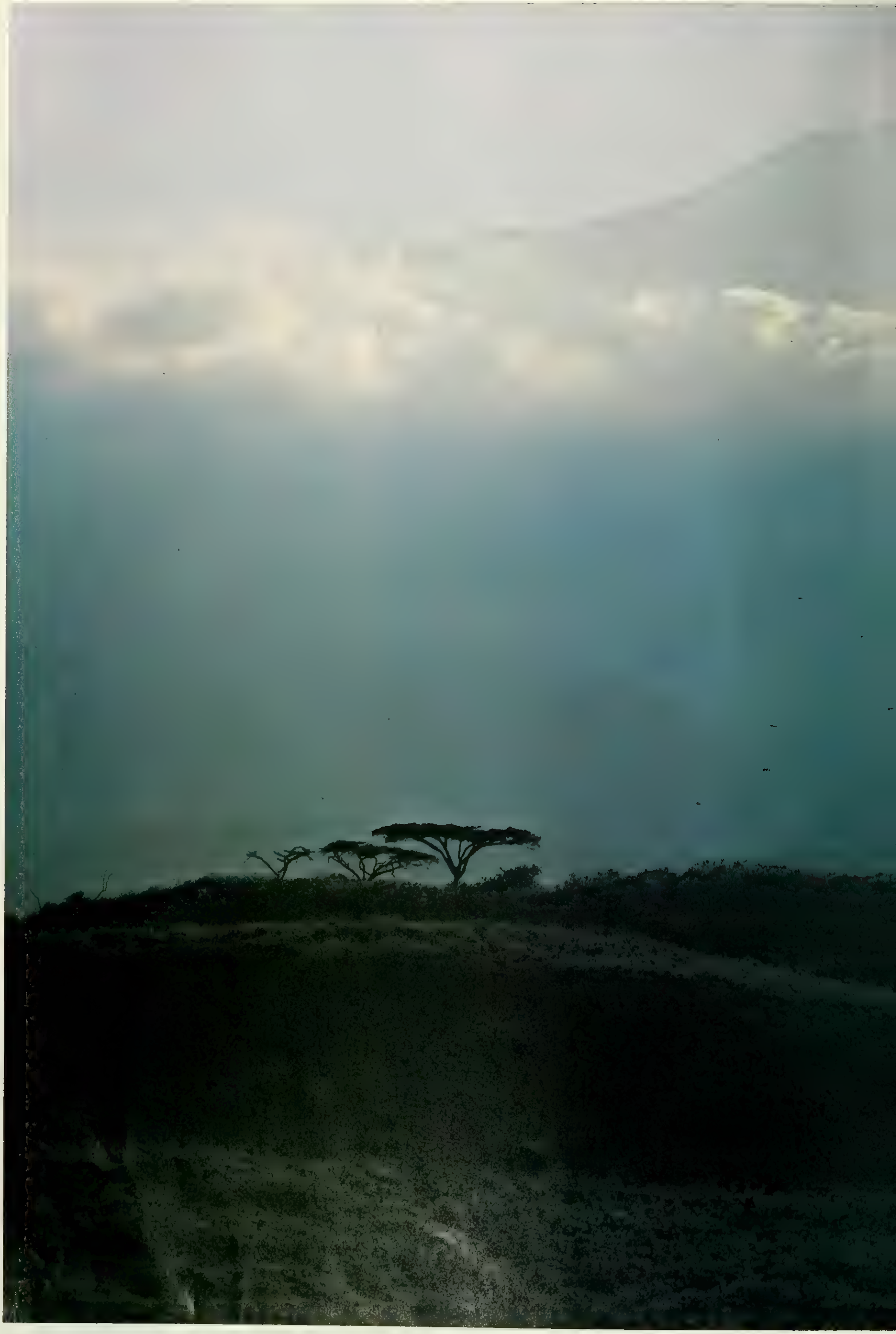
These are only some of the diverse subjects Matthiessen has blended successfully into a completely personal, fascinating text of some 100,000 words. He writes best when he keeps it simple. He describes some birds seen near his camp: "Squalls of finches—fire finches, mannikins, cutthroats, rufous-backs, queleas, cordon bleus, gray-headed social weavers, all intermixed like autumn leaves—blew in and out of a bare acacia, descending in gusts to the water's edge and whirring away again, oblivious of the human presence just across the stream."

Matthiessen's prose can also be a mixture of information and fantasy. "The mbira, or flat-bar zither, came to East Africa centuries ago from Indonesia. It is a hollow box faced with tuned strips of stiff metal that produces soft swift wistful rhythms of time passing. . . ." What does that mean? He might have added that this instrument is usually called a thumb piano, that its most common African name is zanza, and that you can buy a kit to make one in American novelty shops.

There are some superficial errors in the text. The Ruwenzori, which means cloud catcher, is a mountain 16,790 feet high on the border between Zaïre and Uganda that Matthiessen twice refers to as the Ruwenzoris. He writes that the Albert Park is now called Kivu National Park. It is Parc National des Virunga, or Virunga National Park in English, named for the group of volcanoes there. There are several faults in his description of the white rhino that he encountered in the southern Sudan. He writes: "The rhinos were of the rare 'white' (weit, or wide-mouthed) species. . . ." This rhino, *Ceratotherium simum* to be exact, is called the square-lipped rhino and not the wide-mouthed. Matthiessen describes a group of two males, a cow, and a calf together on a hill. No one can tell the sex of an adult rhino unless the animal will allow a close personal examination. I spent five days this year observing and photographing this species in the Garamba Park of Zaïre, an area contiguous to the southern Sudan where a large group of these animals have been preserved. We encountered about a dozen pairs of adult rhinos and several with their young. It is probable that the behavior of these animals differs seasonally, but we witnessed a solitary rhino attempting to join a couple only to be driven off by the other male. As for their being gentle and rarely charging, which the author notes, I wish he had been with me when the wind changed and I ran the fastest hundred yards of my life to get away from one.

It might have been useful to add to the white rhino's description that it is the second largest land animal in Africa after the elephant. This species is the heaviest of all rhinos and can weigh as much as 5,000 pounds. It is also interesting that some of these animals have been moved to a game park in South Africa, where they are thriving. Matthiessen observed

Llo-molo fisherman



these rhinos at Nimule. At the turn of the century, Theodore Roosevelt shot three of them near there as specimens for The American Museum of Natural History.

Matthiessen has gone far from the beaten track in Africa. I cannot understand why he never once climbed one of the three snow-capped mountains: Kenya, Kilimanjaro, or Ruwenzori. I am not recommending the last as a casual climb, but almost anyone can climb Kilimanjaro in two days including the descent. It is a very hard uphill walk, but no ropes or alpine gear are needed. Going up one of these mountains provides an extraordinary opportunity to observe dramatic changes in flora as the altitude increases. There are even some familiar plants from our temperate zone, such as the bracken fern. Clumps of giant bamboo give way to a dim green world where every twisted tree is festooned with epiphytes swaying in the breeze. At about 12,500 feet plant life explodes: lobelias, a tiny plant at home, are ten feet high here; and giant groundsels, cousin of our common aster, look like cabbages on shaggy trees.

Eliot Porter has included photographs of some of these plants on Mount Kenya. Strangely enough, there isn't a single picture of Kilimanjaro—one of the greatest and most famous sights in East Africa—either from the air or the plains below. Porter is justly renowned as a photographer of nature. He is now devoting his life to this pursuit and it is a noble one. His book on Penobscot Bay, *Summer Island,* is sensitive and beautiful. I find a great difference in the quality of *Summer Island* and *The African Experience.* Porter knows and understands Penobscot Bay but not East Africa. He has spent countless days absorbing and then crystallizing his own terrain, but he came to Africa as a visitor, perhaps all too briefly. The text mentions that Porter went on safari accompanied by his two sons, a daughter-in-law, Peter Matthiessen, and two professional hunters, conveyed in two Land Rovers and a truck. I believe Matthiessen had a better

Mount Meru

idea knocking around East Africa in an old Land Rover finding experts like Myles Turner, Iain Douglas-Hamilton, and George Schaller to help him.

Eliot Porter is an outstanding photographer of birds, yet there are only eight photographs out of eighty pages on this lovely and abundant African subject. There are a few magnificent photographs, such as the six giraffes, the elephant and its baby, and the cheetah sequence. There are also some that are ordinary. The single picture of zebra and the two of hippos do poor justice to these photogenic animals. The same may be said for the photograph of buffalo, the animal made famous by Ernest Hemingway in his story "The Short Happy Life of Francis Macomber." Porter is described as a celebrated naturalist by the publisher, yet he captions his picture of two of these animals, considered the most dangerous in Africa, "Water buffalo, egrets, Amboseli." The water buffalo is a domestic animal in the Middle East and Southeast Asia. Those in his picture are Cape buffalo. There is only one egret, not several, and it would have been appropriate to state "cattle egret" since there are several species. All the picture captions are too brief and contribute almost nothing to our appreciation of the subject.

The photographs in this book have a sameness of clarity and bright sunshine. Africa has light and shade, also mist and rain. The sunrises and sunsets are fantastic beyond belief. Anyone who has camped in Africa and left his tent early in the morning is met by a million prisms, the low rays of the red sun caught and multiplied in each drop of dew and refracted from fairy chandeliers of gossamer spider web. What is the most magical moment in East Africa? Twilight, when a whole new dimension absorbs the land and the sky into oneness.

Mr. Porter is not a photographer of people. His portfolio on the Llo-Molo fishermen at Lake Rudolf may be compared to Mireilla Ricciardi's pictures of Turkana fishermen at the same lake that were published this year in her book *Vanishing Africa.* The place is the same but there the resemblance ends. Her portfolio is my candidate for one of the outstanding achievements in recent African photography. Ricciardi's pictures are emotional. Often under- or over-exposed, sometimes soft or blurry, they have their own magic. They could be compared to Matthiessen's text; vistas whose only limit is the printed page. Porter's camera is often pointed straight down, superb details of nature with an absolute clarity that leaves nothing to the imagination. There isn't even one photograph in *The African Experience* of the multitude of animals that still abound in this great land.

The editorial judgment that organized the photographs into seven portfolios of disparate subjects must be criticized. One set mixes the foliage high on a mountain with the fishermen of Lake Rudolf. Another is a mishmash of Mount Meru foliage, the shores of Lake Rudolf, the flamingos of Lake Natron, the top of a mountain, and acacia trees on the plains. Another editorial fault is the lack of a glossary of scientific names. Surely one could afford a few pages for a list that would not interfere with the rhythm of Matthiessen's writing. Finally, the language families maps included in this book seem more appropriate for a linguistics study. What is needed is an old-fashioned, traditional map of the authors' travels, allowing us to follow them with a dotted line. Although I have now made eight extensive trips in Africa, I would have found this very useful.

Matthiessen has written a beautiful passage that seems appropriate to close this review. "Lying back against these ancient rocks of Africa, I am content. The great stillness in these landscapes that once made me restless seeps into me day by day, and with it the unreasonable feeling that I have found what I was searching for without ever having discovered what it was. In the ash of the old hearth, ant lions have countersunk their traps and wait in the loose dust for their prey; far overhead a falcon—and today I do not really care whether it is a peregrine or lanner—sails out over the rim of rock and on across the valley. The day is beautiful, my belly full, and returning to the cave this afternoon will be returning home. For the first time I am in Africa among Africans. . . ."

Eliot Elisofon has produced three African books: The Sculpture of Africa, The Nile, *and* African Animals. *A former* Life *photographer, he has recently made the TV documentary "Black African Heritage."*

Hawaiian Land Mammals, by R. J. Kramer. *Charles E. Tuttle Co., $12.50; 347 pp., illus.*

Before Polynesian inhabitation of Hawaii only two species of land mammals lived in the Hawaiian chain: the Hawaiian bat and the Hawaiian monk seal. Nature has seldom been noted for being lavish in her provision of higher animals on isolated islands, and because populations of these two remarkable and unique mammals have never been great, their life histories are not well known. If a naturalist of today found himself in Hawaii before the aboriginal invasions that began about the second century A.D., he would have little to report on mammals and certainly not enough to write a book about.

Not so today, thanks to Polynesian customs regarding food staples, worthy objects for hunting, and religious beliefs. Thanks are also due to the introductions and escapees from countless vessels that replenished provisions and sampled Hawaii's charms during the last two centuries. In more recent times, additional sources have been those careless Hawaiian citizens who have lost their exotic pets and zoo keepers who have lost their charges. Today, no less than 22 mammalian species successfully live in feral conditions in the Hawaiian Islands. This diverse and unlikely assemblage ranges from the brush-tailed rock wallaby of Australia, to the mouflon, to the ubiquitous black, brown, and Polynesian rats and house mice, which cause sugar cane growers so much alarm, to the small Indian mongoose imported from Ja-

A cheetah in the Serengeti

maica to control them (a function at which it has, in spite of its expansive tastes, been partially effective).

After a brief introduction that gives the reader some orientation regarding Hawaii and the basic characteristics of mammals in general, Kramer's book proceeds on a random, animal-by-animal basis. Each animal is discussed under headings of history, description, distribution, behavior, parasites, and public health importance; and each species averages 16 pages of discussion. Sections on some of the more troublesome species, such as the feral goat and the mongoose, or the more tenderly nursed introductions (the mouflon, American pronghorn) include discussions of their future prospects. Some mammals, such as the cavy and water buffalo, having only briefly lingered on the Hawaiian scene, are nevertheless included, as is a discussion of the long-extinct native Hawaiian dog, a beast whose basic appearance is still debated.

Photographs are rare and relate either to particular mammalian characteristics such as the "bumps" on the soles of the rock wallaby, or to immature animals (monk seal). They impart to the reader some feel of earlier times, for example, a cowboy and his burro or a sheep drive. Animals are primarily illustrated by the pencil sketches of Khan Pannel, and I found them dynamic and thoroughly delightful if not always technically exact. Often only a partial view of the animal is drawn. For the larger herbivores especially, the perspective often prevents accurate size estimates. Field identification of mammals in Hawaii, however, is not a difficult matter even for the unprepared visitor, except possibly with regard to the rats.

Mr. Kramer draws upon his long experiences in Hawaii as a wildlife biologist with the Division of Fish and Game for a revealing picture of the future prospects for many species, recognizing the crossfire that the division often faces from hunters, conservationists, public health officials, the U.S. Park Service, and others. Case in point: the feral goat whose overgrazing has endangered the flora of many natural areas and created serious erosion problems. Hunters are reluctant to lose the plentiful and easy game that the goats now represent. The division has been partially successful in organizing coordinated hunting seasons on the many huge ranches that fence in much of the islands, yet the goats thrive on hundreds of acres of national park land where they are ironically protected by federal law. Efforts are currently under way to exterminate the goats and introduce more noble and less destructive targets, for both the Hawaiian providing food for the table and the visitor in search of a trophy head. The mouflon and pronghorn are examples of replacement species tried on the sportsman, and the axis deer is scheduled for future release on the big island of Hawaii. Yet the easily won feral goat can admittedly make an impressive mount, and conservationists are running rabid at any further mention of the word "introduction."

It is as discouraging to discover how little is known of many of Hawaii's mammals as it is to read their history, follow current sentiment in regard to their management, and speculate on their ultimate fate in Hawaii. Besides providing information, Kramer's book will possibly stimulate additional and much-needed research on Hawaiian mammals or cause politicians and the public to deal with issues involving native flora and fauna on a more factual basis, recognizing the value that their protection and wise management represents.

The International Biological Program's island ecosystems stability and evolution subprogram in Hawaii, now in its second year, promises an integrated look at Hawaii's biota that should provide many insights into what could constitute wise wildlife management practices in the islands. It is already clear, however, that Hawaii, initially so hospitable to all her mammalian visitors and settlers, has now been perhaps irrevocably injured by their continued presence and unregulated growth and by the destruction of the natural biota that is, or was, unique upon the earth. Unless appropriate action is taken soon, it is unlikely that any future book on Hawaiian flora or fauna will ever be able to conclude on an optimistic note.

Perhaps Mr. Kramer might well have concluded with a final section

in his book about man in Hawaii, and his incomparable predilection for asphalt and urban sprawl, pollution, monoculture, economic greed, and thoughtless introductions of both plants and animals in a land that has become an overloaded ark. Here, as elsewhere, man's wisdom, or lack of it, will certainly determine the ultimate future of his lesser brethren, as well as himself.

Granted three wishes, my first would be to save this jewel in the Pacific for future generations to enjoy. Barring magic, Kramer's book is a good step in the right direction.

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57—Thomas Beiswenger
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60—Marli Shamir
62-63—AMNH after Imperato
65-68—Pascal James Imperato
69—Marli Shamir
70-71—World Wildlife Fund
72—Jeremy Griffith
74-75—Thylacine Expeditionary Research Team
76-77—Don Stephens
82-86—Frederic Lewis, Inc.
89—Amer. Mus.-Hayden Planetarium
91—Helmut Wimmer
93-96—Eliot Porter

GARUDA is a part-bird, part-human deity who is worshiped by Hindus and Buddhists, as well as by the followers of Bon, the pre-Buddhist religion of Tibet.

Suggested Additional Reading

THE MYSTERIOUS FALL OF NACIREMA

America the Raped. G. Marine. Avon Books, New York, 1970.

The Last Landscape. W.H. Whyte. Anchor Books, Garden City, 1968.

Silent Spring. R. Carson. Crest Books, New York, 1970.

The Body Ritual of the Nacirema. H. Miner. *American Anthropologist,* June, 1956.

GEORGE CATLIN: PICTORIAL HISTORIAN OF ABORIGINAL AMERICA

Episodes from Life Among the Indians and Last Rambles. G. Catlin. M.C. Ross, ed. University of Oklahoma Press, Norman, 1959.

Letters and Notes on the Manners, Customs, and Condition of the North American Indians. G. Catlin. Wiley and Putnam, New York, 1841.

George Catlin and the Old Frontier. H. McCracken. The Dial Press, New York, 1959.

Last Rambles Amongst the Indians of the Rocky Mountains. G. Catlin. D. Appleton & Company, New York, 1867.

A MOST SOCIABLE BIRD

Life Histories of North American Woodpeckers. A.C. Bent. Dover Publications, New York, 1939.

Ecological Adaptations for Breeding in Birds. D. Lack. Barnes and Noble Books, New York, 1968.

Animal Dispersion in Relation to Social Behaviour. V. Wynne-Edwards. Hafner Publishing Company, Inc., New York, 1962.

A TRILOBITE ODYSSEY

Evolution of the Earth. R.A. Dott, Jr., and R.L. Batten. McGraw-Hill Book Company, New York, 1971.

Ancient Environments. L.F. LaPorte. Prentice-Hall, Inc., Englewood Cliffs, 1968.

A Natural History of Trilobites. H.B. Whittington. *Natural History,* August-September, 1961.

The History of Life. A.L. McAlester. Prentice-Hall, Inc., Englewood Cliffs, 1968.

NOMADS OF THE NIGER

Savannah Nomads. D.J. Stenning. Oxford University Press, New York, 1959.

Peuls Nomades. M. Dupire. Institut d'Ethnologie, Vol. 64, Paris, 1962.

THE SEARCH FOR THE TASMANIAN TIGER

Tasmanian Wildlife. M. Sharland. International Scholarly Book Service, Portland, 1963.

Furred Animals of Australia. E. Troughton. Angus and Robertson, Sydney, 1941.

Thylacine. In Survival Service Commission Red Data Book. International Union for Conservation of Nature and Natural Resources, January, 1966.


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